VOLUME IX. NUMBER 1

# THE JOURNAL
## OF
# THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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## OF CANADA

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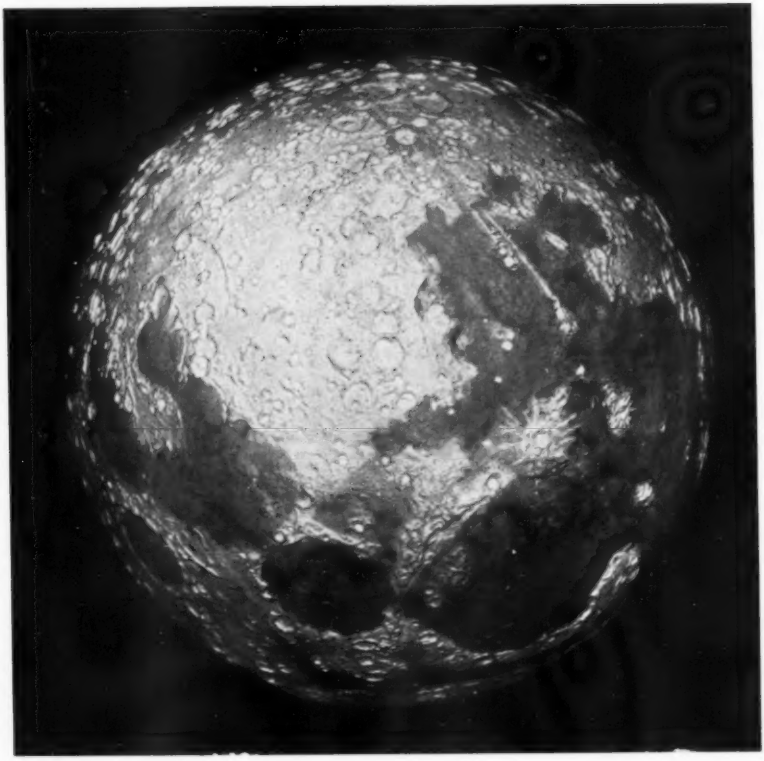
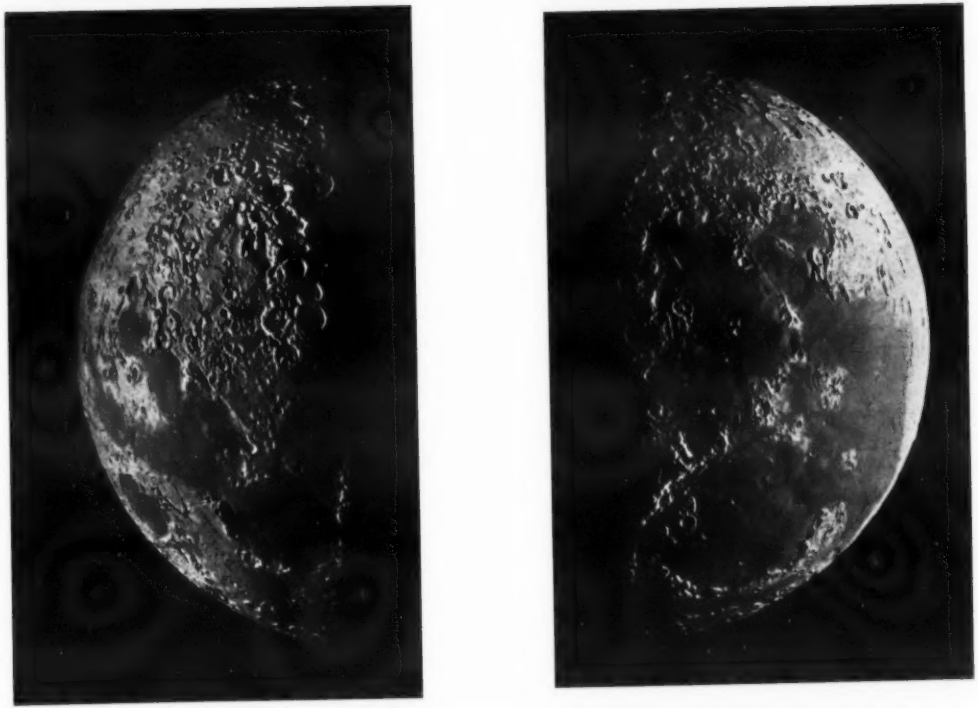


PHOTOGRAPH OF THE MODEL OF THE MOON,
SHOWING FULL MOON.



PHOTOGRAPHS OF THE MODEL OF THE MOON, ILLUMINATED SO AS TO SHOW THE FIRST AND LAST QUARTERS

*Journal of the Royal Astronomical Society of Canada, 1915*

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## HOW I SCULPTURED THE MOON

BY HERBERT B. COLLIER

I HAD long cherished the desire to sculpture the moon, mainly for the purpose of attaining greater familiarity personally with every detail of its surface. And therefore I make confession that the educational value was uppermost in my motive, with the artistic feature in secondary place. Possibly the artist-love later assumed a commanding position and assisted progress over the tedious portions of the eight months' task. But a moon of fact, not of fancy, was ever the objective.

Though my eye had registered through the telescope, thousands of impressions of the surface markings of the moon, and I had thereby become quite familiar with them, I dared not trust the eye solely in transferring these to sculpture. Accuracy of result demanded exact measurements. An unchanging record is presented by telescopic photographs. They give an indelible impression of what is revealed by the instrument, and such permanent record is ready for investigation at all times. Beyond question photography pre-eminently has enabled astronomy to merit the title, given it to-day, "The Most Exact of Sciences." Therefore I made as the foundation of my work the best series

of photographs of the moon that the world has to-day, the *Paris Lunar Atlas*.

With the kaleidoscopic changes of light and shadow on the moon, years of patient devotion to the task was necessary, before M. Loewy and his colleague M. Puiseux of the Paris Observatory could complete a series of photographs covering properly the detail of the lunar surface. Each of these gives in great detail one small region. Possibly but one or two craters of importance are to be seen clearly. Another picture of the same region, but under different light conditions will change the apparent physical features to a remarkable degree. Thus it is necessary to carefully compare a series of such photographs in order to arrive at a full understanding of the real topography. Accuracy demands distinction between the shadow of a mountain crag and the dark depths of a crater. Such was the real burden of my undertaking. With a hundred photographs ever before me, the real task was to judge the evidence therein presented in so many forms. Those wonderful pictures comprise a catalogue of the topography of the moon, presenting far more minute details of the surface of our satellite than we know of our own earth in many regions. The *Atlas* was to me a guide book surpassing, for the purpose, even a personal visit to the celestial body.

Fearful, lest through lack of knowledge of the technique of sculpture I should waste much valuable time, I devoted some months to the study of this special feature. Then after consultation with a number of skilful artists I commenced operations.

Plasticine appeared best suited to the conditions under which the work would be pursued. It is non-drying and responds quickly to manipulation with a tool. A sitting of three or four hours, then a day or two and another sitting, just as spare time permitted, proved plasticine an excellent medium for the purpose.

The question of size found answer in the selection of a scale of 180 miles to the inch. The moon having a diameter of 2160

miles thus brought the model to a measurement of twelve inches. This was a convenient workable basis which proved satisfactory in every respect.

With provoking constancy does the moon present but one side to our view. It is true "libration" permits a peep at times of a little more of the "edges" than the exact half, really a total of 59 per cent. of the entire surface. Consequently half a sphere is all that is needed to represent the details of the surface characteristics of the earth's satellite, which are known to mankind. Therefore as a foundation for my model, I constructed a hemisphere of selected well-dried wood, laminated to prevent warping. The entire surface was then liberally coated with shellac. With a diameter of eleven inches, this wood core allowed a blanket covering of plasticine one-half inch in depth, thus giving a total diameter of twelve inches. A board 16 by 24 inches served as a base and to this was fastened the hemisphere of wood and plasticine. The preparations were now complete. Noting the date, May 1st, 1913, actual operations commenced. It was some eight months later when the finishing touches were applied.

The photograph of a ball such as the moon, presents some peculiarities. Take a twelve-inch photograph of a twelve inch ball, superimpose the apparent centres, at the same time wrapping the photographic print around the face of the sphere. It is immediately seen that they do not correspond, and will not fit. The print lacks practically seven inches of covering its prototype. The reason for this is quite evident. If the photograph is kept flat and vertical lines are projected to the surface of the ball, they coincide perfectly. This tersely explains the method I adopted on account of its simplicity in transposing scale calculations.

A photograph of the full moon is very much like the preliminary sketch of the landscape artist. The seas, those great dark regions which even the naked eye discerns plainly, are nicely outlined. Some of the more prominent craters are noted. The more important mountain ranges are roughly indicated. But the details of all these are to be shown later. I first selected such

a picture, an excellent one from the Brashear telescope of my friend, Rev. D. B. Marsh, F. R. A. S. Being just twelve inches in diameter, it served the purpose admirably of an outline sketch or key. Various points on this were chosen and soon projected to the model. As the work progressed, craters and prominent physical features, visible only in other photographs, were first given their proper locations on this key that they might thereby be accurately placed on the model.

In order to give to the eye the effect attained by telescopic observation, I took the liberties of the artist and departed from scale measurements in one respect. With 180 miles to the inch a distance of two miles on the moon would be one-ninetieth of an inch on the model. This is less than the thickness of your business card. A lunar precipice of two miles would be a very prominent object under proper lighting conditions, and be worthy of special attention. Yet an elevation of but one-ninetieth of an inch on the model would be merely the thickness of a coat of paint! Therefore the elevations were accentuated in order to produce to the eye a natural appearance, for the strict adherence to scale in this respect would create misconceptions. Careful comparison of photographs of the real moon and the sculptured one, under approximately similar lighting, shows marked contrast. But this was a feature that was not in the least considered important. My aim was not to attain photographic similarity, but to convey to the eye under daylight conditions, details apparent only on rare occasions with the telescope. The scientific here gave place to artistic. For such departure I plead merciful consideration from my scientific friends.

In the plaster casts made from the original, many of the finer details have been lost. As a light fall of snow on rough ground spreads a brilliant blanket, while leaving still the form of every stone and every hummock, so in the casting the plaster obliterated the harshness of the model, softening all to a pleasing degree. A realistic telescopic appearance resulted, which in some respects compensated for the departure of details obtained only after much labor. By a careful application of pigments of a

bluish gray tint the maria were given a sufficient contrast to the snow-white plaster mountains to form in all an ideal full moon.

A very interesting question appeared while calculating measurements, "What is the smallest possible discernible object on the moon? Could you see a man there? Would a big tree show?

The average human eye is credited with the power of appreciating an angle of about half-a-minute of arc. This, however, is quite unintelligible to most people. Let us simplify it. It means that you should see an object one-inch in diameter at a distance of about five hundred and forty-five feet. This would indicate that a "beauty plaster" of one-eighth-inch diameter upon the fair cheek of the debutante should be visible at some sixty-nine feet. Applied to the moon, which averages in size thirty-one minutes of arc, the unaided eye is capable of discerning a spot measuring one-sixtieth of her diameter, or about 30″. Now a linear mile on the moon corresponds to 0″·87. Therefore, a region one mile square must be magnified by artificial means to equal 30″, in order that the eye may even perceive it as a *point*. The power required for this is evidently about thirty-four. Measurements show that a second of arc represents about two thousand yards on the moon. Thus, we would have to magnify an object of that size thirty times to bring it to discernible proportions. Two hundred yards would require ten times this power or 300 magnification. Consequently twenty yards would demand a magnifying power of 3,000! There must be a very fine atmosphere to admit of the use of a power of 500; while 1000 power is quite the limit. Even this latter magnification would bring the moon apparently to a distance from the eye of some 240 miles, and no object under sixty yards could possibly be detected, according to our basis of reasoning. It is quite evident that a man could not be seen. A big tree would not show. Aided by the most powerful telescope and under conditions of magnification verging upon impracticability, it would be doubtful if an object less than one hundred yards in diameter would be discernible to the human eye as anything but a mere speck. With but one hundred miles separating you

from a mountain, and with ideal atmospheric conditions, judge for yourself what little your naked eye could determine of the details at that distance.

Somewhat startling is the statement that the end of a pencil held at arm's length completely covers the moon. In view of the oft heard expression, "The moon was as big as a wash-tub," the pencil comparison seems almost ridiculous. However proof of this is readily presented.

The artist aims in his painting to present a scene perfect to the eye at a certain focal distance. The untutored eye hastily condemns the brush marks seen at close range, which, however, at the proper focus dissolve into the harmonious conception of the artist. To see the painting as intended, the eye must be at the right distance. And thus came the inquiry to my mind as to the actual distance at which the sculptured moon should be placed to correspond exactly to the earth's satellite in relation to us. There are several methods of dealing with this problem, one only of which I shall mention in view of its simplicity.

The diameter of the moon is 2160 miles and the mean distance from us 238,840 miles, approximately 110 moon diameters. Therefore the sculptured moon should be placed at a distance equal to 110 times its diameter, or 110 feet. Thus a rule may be deduced applicable to any size of disc, as follows: — Place the disc at a distance of 110 of its diameters from the eye, and the size of the moon (at its mean distance from the earth) will be approximated. From this it is evident that the pencil of five-sixteenth of an inch diameter equals the moon in apparent size when held 34 inches, or 110 diameters, from the eye.

To add to the usefulness of the model I made a chart of the moon giving numbers and corresponding names to some half-thousand prominent craters and other objects of interest in the topography of the satellite. Of course this all required patience and some mental discipline, but the benefits of it I now appreciate so much, that I am constrained to heartily commend the process to my fellow amateur astronomers.

Toronto, Ont.

# A GNOMONIC STAR ATLAS*

By Reynold K. Young

THE following set of thirteen maps is intended to facilitate the observation of meteors and the plotting of their paths.

When a meteor passes the sky an observer may note its position from one point on its path and its direction or from two points on its path. Most observers prefer the first method. The one point is taken where most convenient, perhaps near a bright star or perhaps part way between two bright stars, and the direction is fixed by mentally producing the meteor track backward or forward to find some mark which would have been in line had the track been sufficiently long. A straight edge held along the path at the instant of observation will greatly assist in this operation. When the position of the meteor has been mentally fixed it should be traced on a star map with an arrow to indicate the direction of flight. Other things to be noted at the moment are, the time, the brightness, the color, the speed, the duration of flight and the character of the train left, if any, or other unusual circumstance.

The observer on studying the observations taken on any one night, among other things, should endeavor to locate points from which several meteors may have proceeded, the so-called radiants. These points are discovered by producing the observed paths backward. This operation is legitimate only on a celestial globe or on a star map so constructed that great circles are projected as straight lines. We know that the meteor is moving about the sun in consequence of the law of gravitation and that we see it in virtue of its encountering the earth on its way.

* A Gnomonic Star Atlas has already been published by R. A. Proctor. Several features of this map are distinctly different from the present Atlas.

Therefore the meteor, the earth and the sun lie in the orbit plane of the meteor. The observer sees the meteor where this plane cuts the celestial sphere and since the plane passes through the centre of the sphere (the earth) the observed path must be a portion of a great circle. It is evident then that the map used must have this property, that great circles in the sky are straight lines on the map; otherwise the produced portion of the meteor path will be in error.

The accompanying charts are constructed on the gnomonic or central projection which gives this desired property. The maps have been made especially for the convenience of meteor observers. It is hoped that the position of the stars as given will be found in general to be correct to within one-tenth of one degree for the epoch 1900. Nothing has been plotted which was deemed unnecessary and which might confuse the maps. All stars down to 5·0 magnitude inclusive have been plotted as well as the brighter variables. The right ascension circles for every hour and the declination circles for every ten degrees have been drawn in. In order to make the reading of positions from the map easier as well as more accurate, the intermediate positions of the right ascension circles for every twenty minutes and of the declination circles for every five degrees have been indicated. This procedure avoids the confusion which might result if all the lines had been drawn in full. The generous overlapping of the charts will prove helpful.

For those who may desire to add the positions of objects or compute the position of the radiants rather than read them off from estimation of their distance from the hour and declination circles, the method of construction of the maps is briefly outlined.

For the circumpolar map, the celestial sphere is imagined cut by a plane which includes a segment of the sphere sixty degrees in diameter. Any point in this segment is projected on the plane by joining it to the centre of the sphere. The north celestial pole may be called the axis of projection. The right ascension circles are straight lines uniformly distributed around

## GUIDE TO THE CONSTELLATIONS

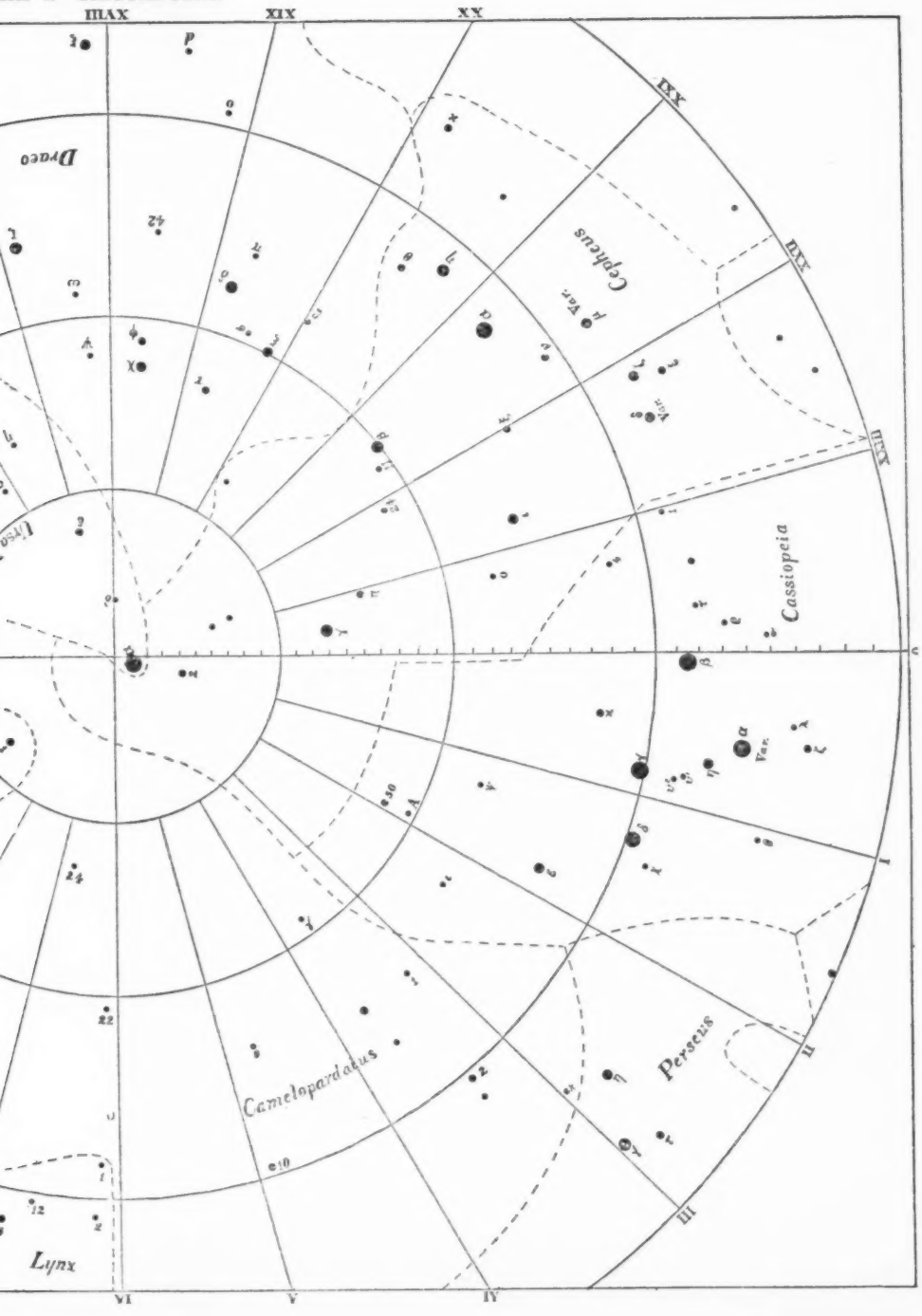
### GIVING THE MAPS ON WHICH THE CONSTELLATIONS ARE TO BE FOUND

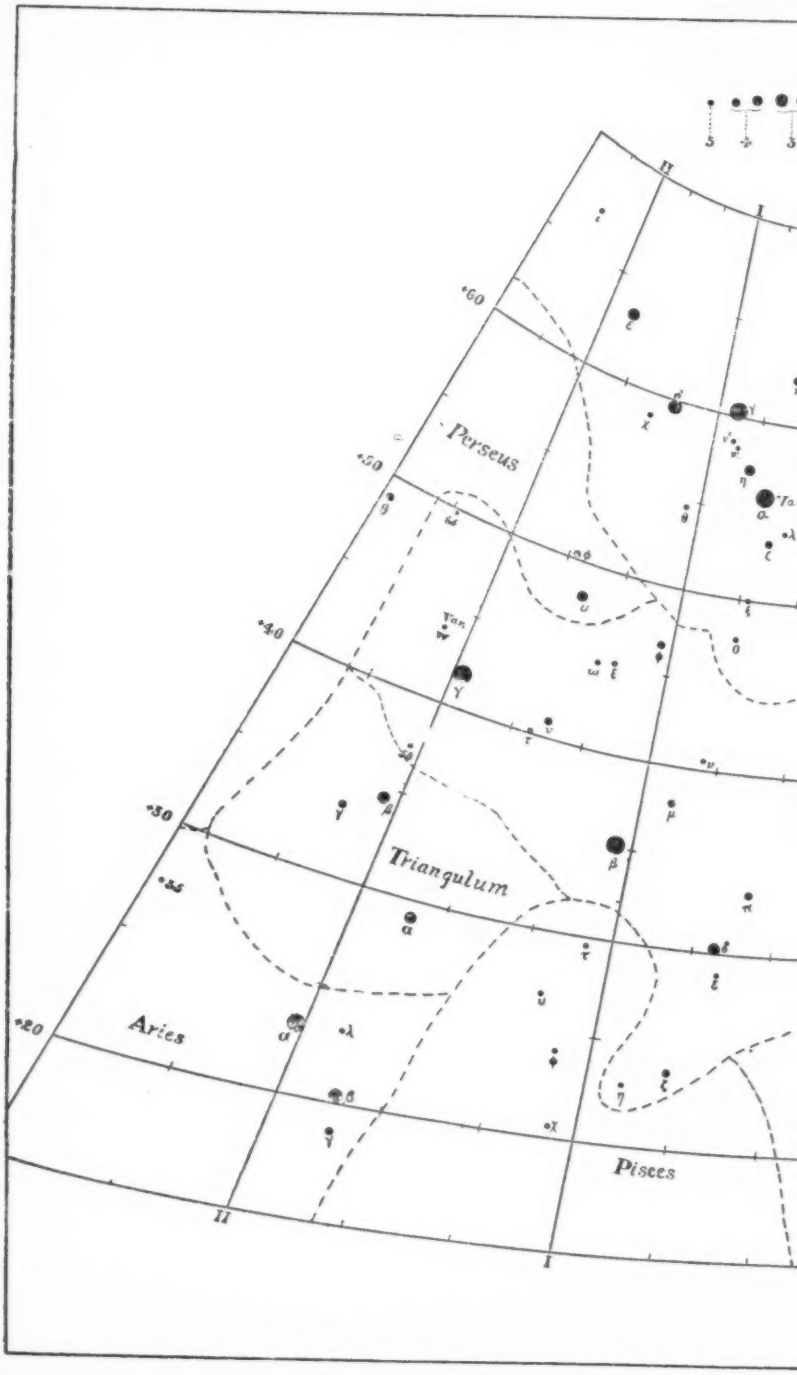
Andromeda, II., III., VIII.
Antlia, XI.
Aquarius, VIII., XIII.
Aquila, XIII.
Aries, II., III., VIII.
Auriga, III., IV., IX.
Boötes, I., V., VI., XI., XII.
Camelopard, I., III., IV.
Cancer, IV. X.
Canes Venatici, V., VI.
Canis Major, IX., X.
Canis Minor, X.
Capricornus, VIII. XIII.
Cassiopeia, I., II., III.
Cepheus, I., II., VII.
Cetus, VIII., IX.
Coma Berenices, V., XI.
Corona Borealis, VI., XII.
Corvus, XI.
Crater, XI.
Cygnus, II., VII.
Dephinus, VII., XIII.
Draco, I., V., VI., VII.
Equuleus, XIII.
Eridanus, IX.
Fornax, IX.
Gemini, III., IV., IX., X.
Hercules, VI., VII., XII., XIII.
Hydra, X., XI., XII.
Lacerta, II., VII.
Leo, IV., V., X., XI.
Leo Minor, IV., V.
Lepus, IX., X.
Libra, XII.
Lupus, XII.
Lynx, I., IV.
Lyra, VI., VII.
Monoceros, IX., X.
Ophiuchus, XII., XIII.
Orion, III., IX., X.
Pegasus, II., VII., VIII., XIII.
Perseus. I. II., III.
Pisces, VIII., IX.
Piscis Austrinus, VIII.
Puppis, X.
Pyxis, X.
Sagitta, VII., XIII.
Sagittarius, XII., XIII.
Scorpio, XII.
Scutum, XII., XIII.
Serpens, VI., XII., XIII.
Sextans, X., XI.
Taurus, III., IV., IX., X.
Triangulum, II., III.
Ursa Major, I., IV., V. VI.
Ursa Minor, I.
Virgo, XI., XII.
Vulpecula, VII., XIII.

MAP I.—


XVII
XVIII
XV
Bootes
XIV
XIII
Draco
Lyncis Minor
XII
XI
Ursa Major
X
IX
VIII
VIIA
IIIA
Lynx

MAP I.—CIRCUMPOLAR




Perseus
Triangulum
Aries
Pisces
°60
°50
°40
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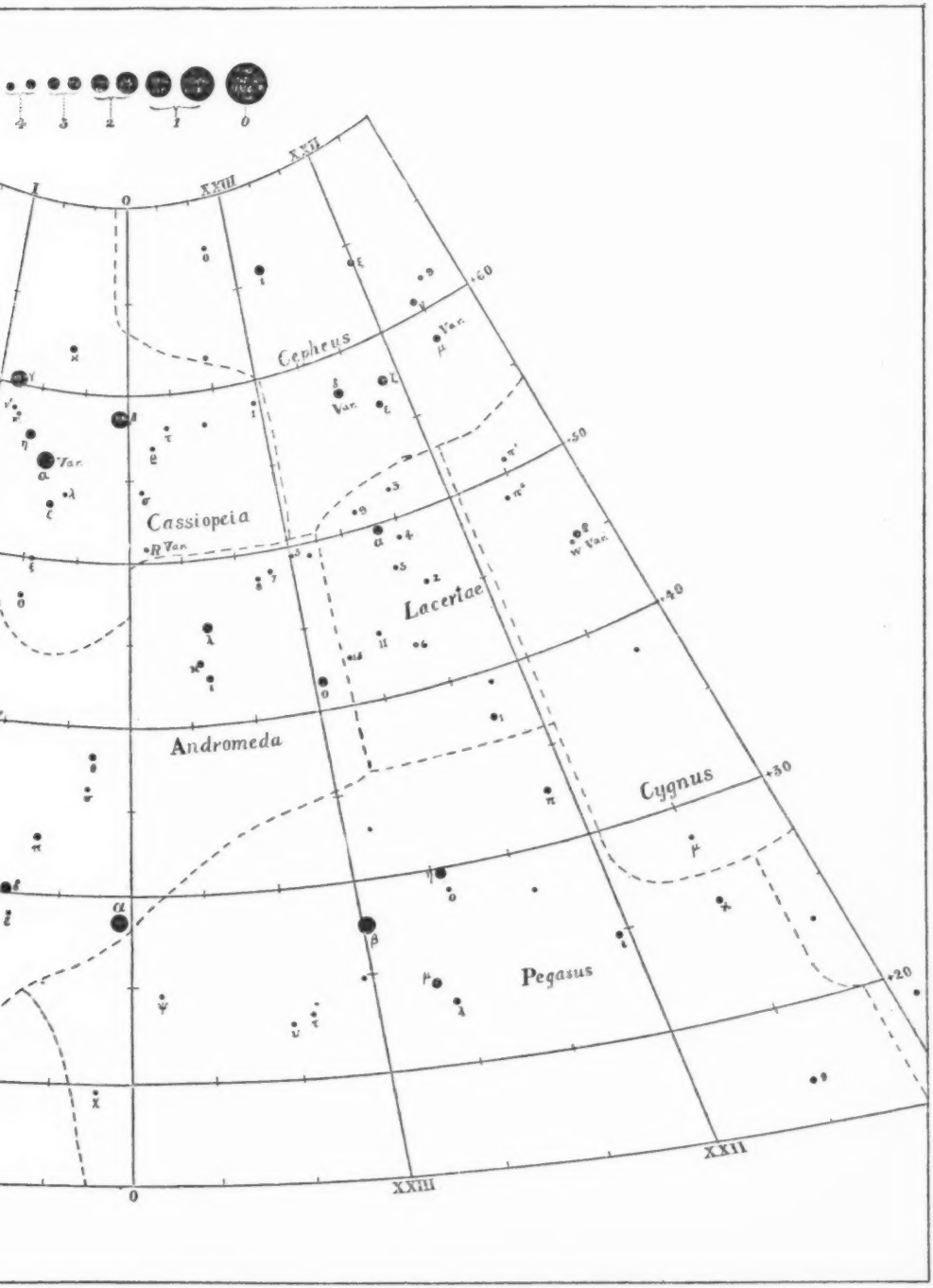
°20
II
I


-2
3
2
1
0
XXIV
XXIII
XXII
0
+60
+50
+40
+30
+20
Cepheus
Cassiopeia
Lacertae
Andromeda
Cygnus
Pegasus
Var.
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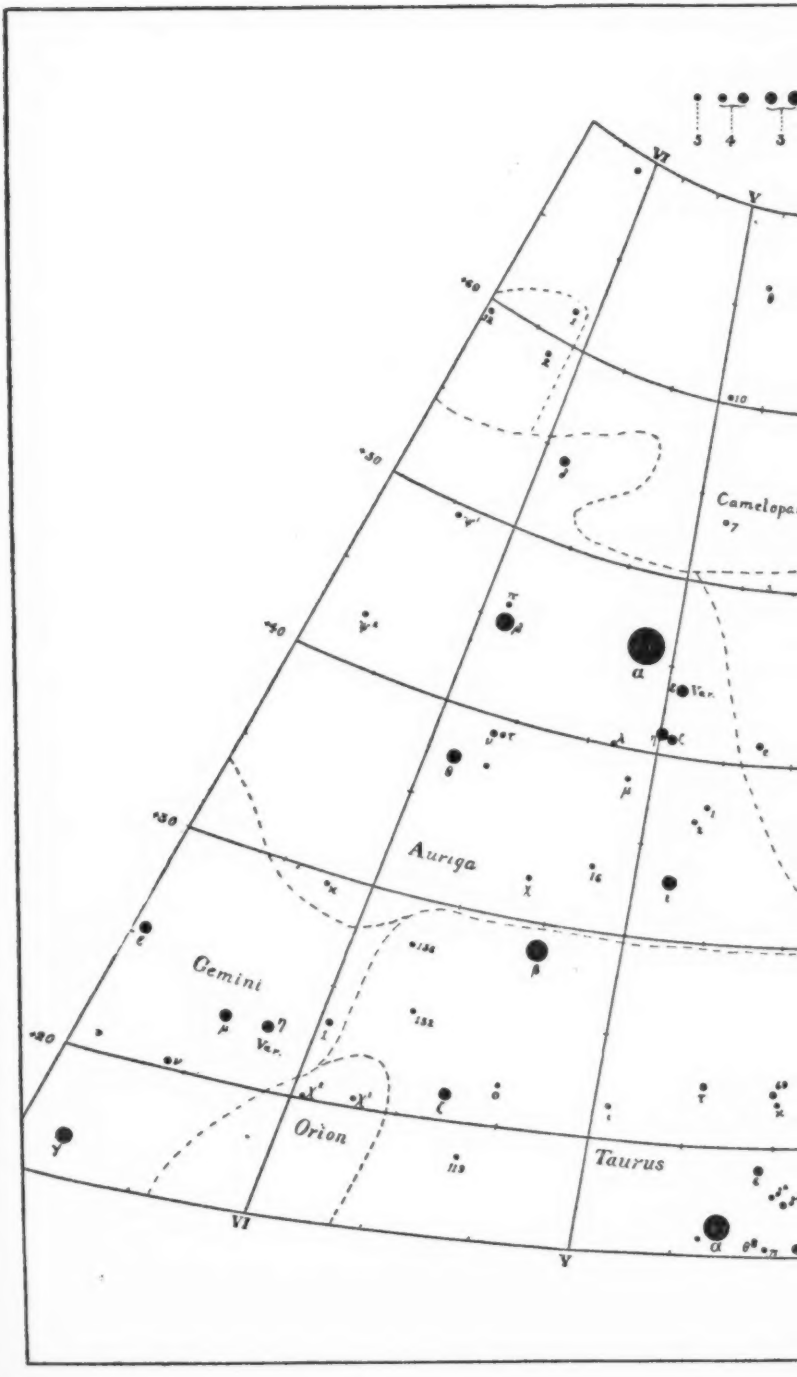
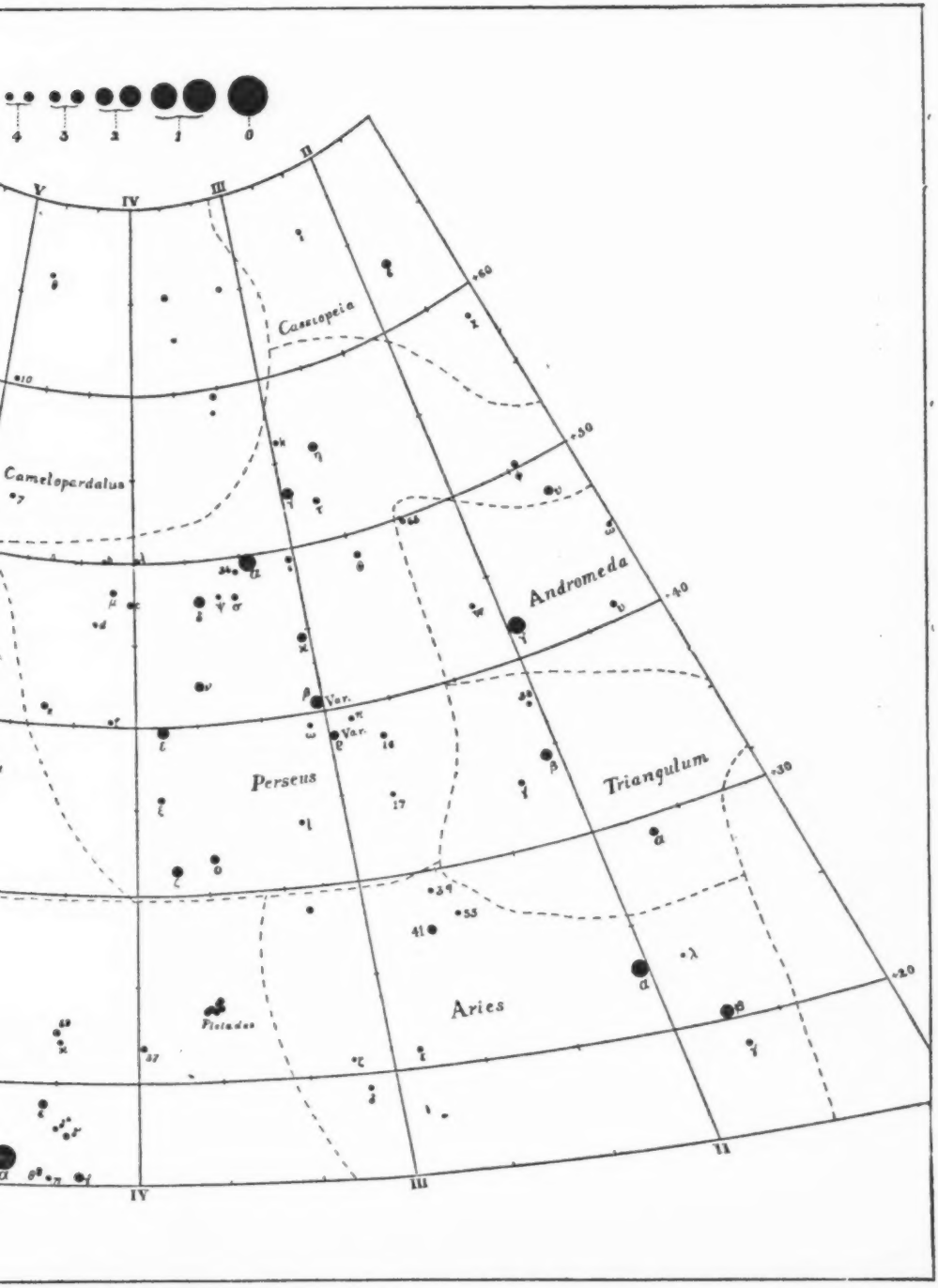
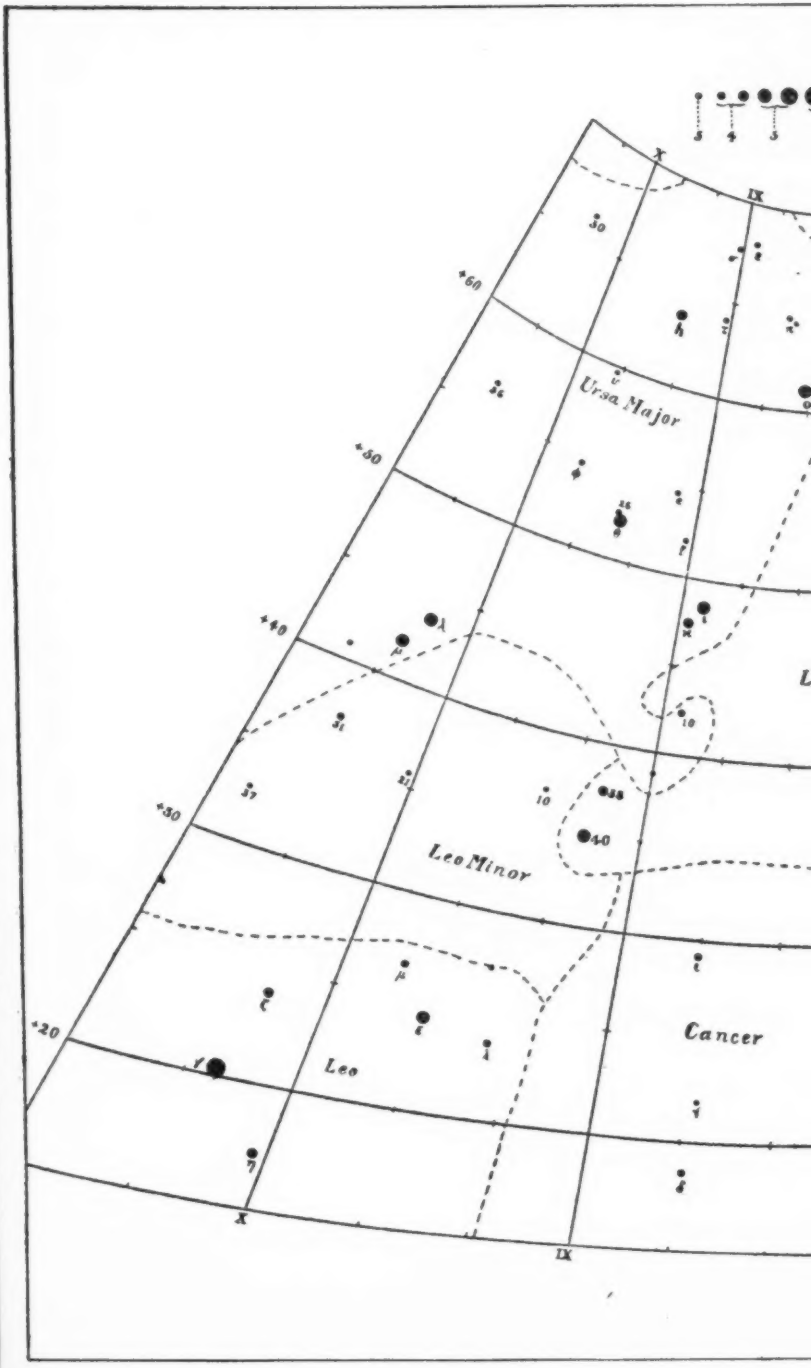
XXIII
XXII

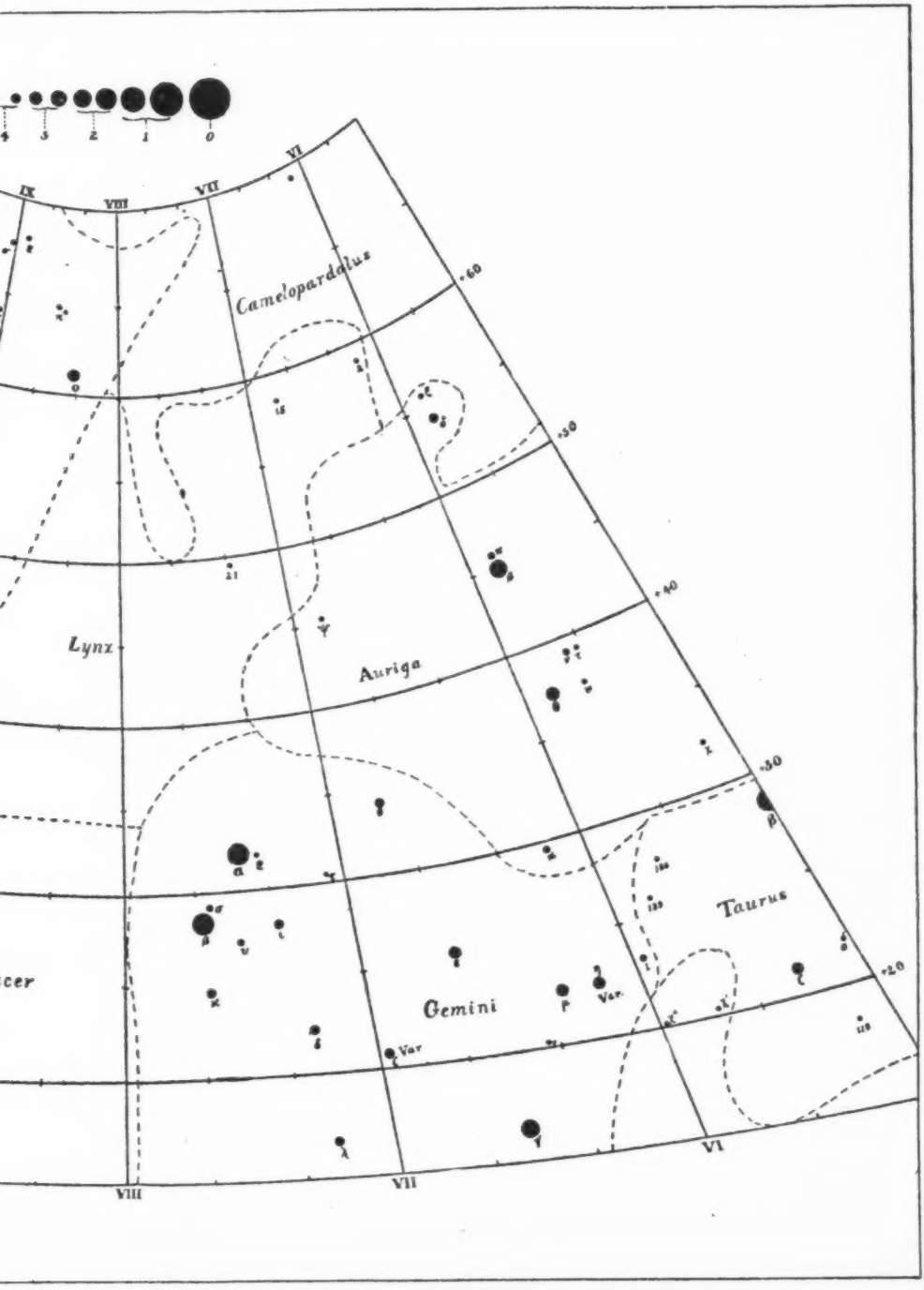

3
4
3
VI
V
+60
+50
+40
+30
+20
Camelopa
Auriga
Gemini
Orion
Taurus
VI
V

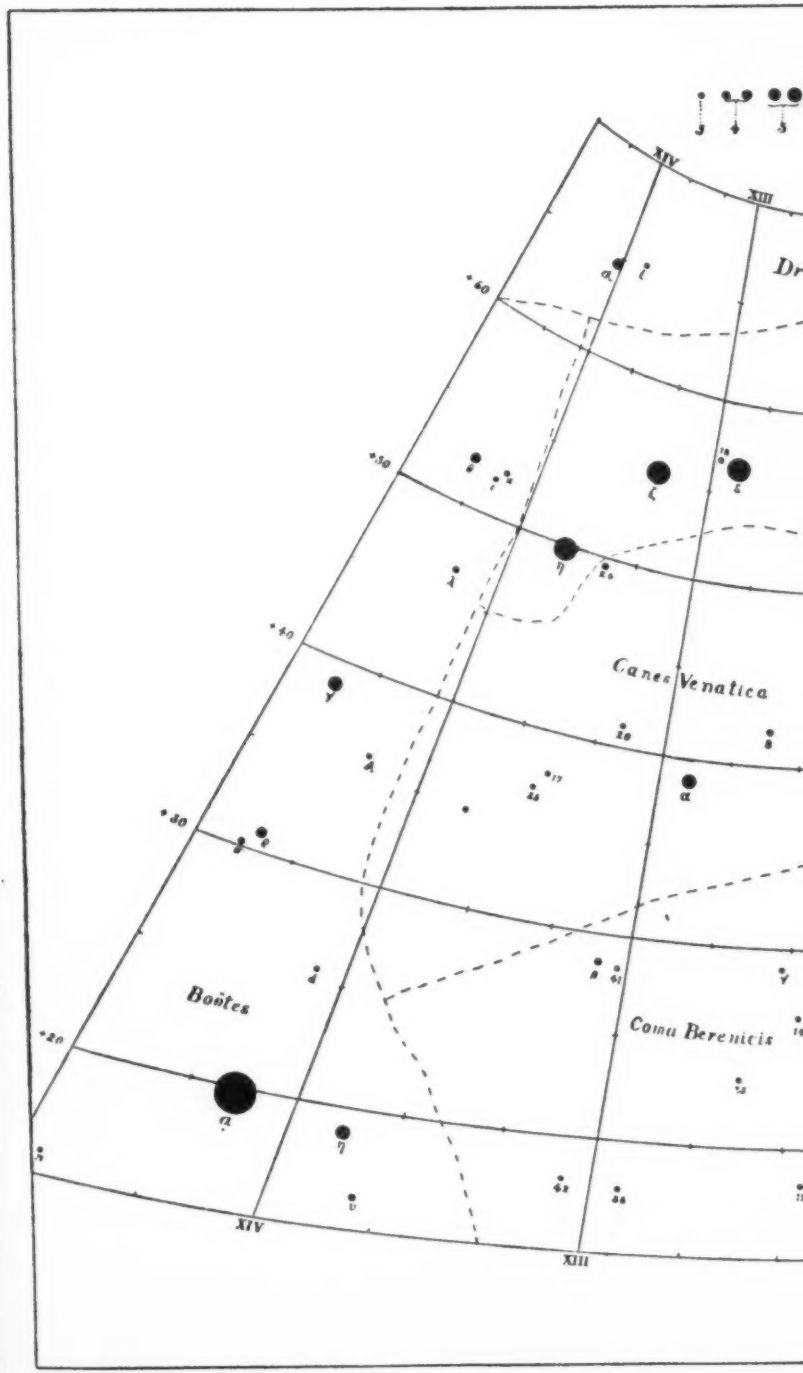
III.—A.R. IV. hours, Decl. + 40°



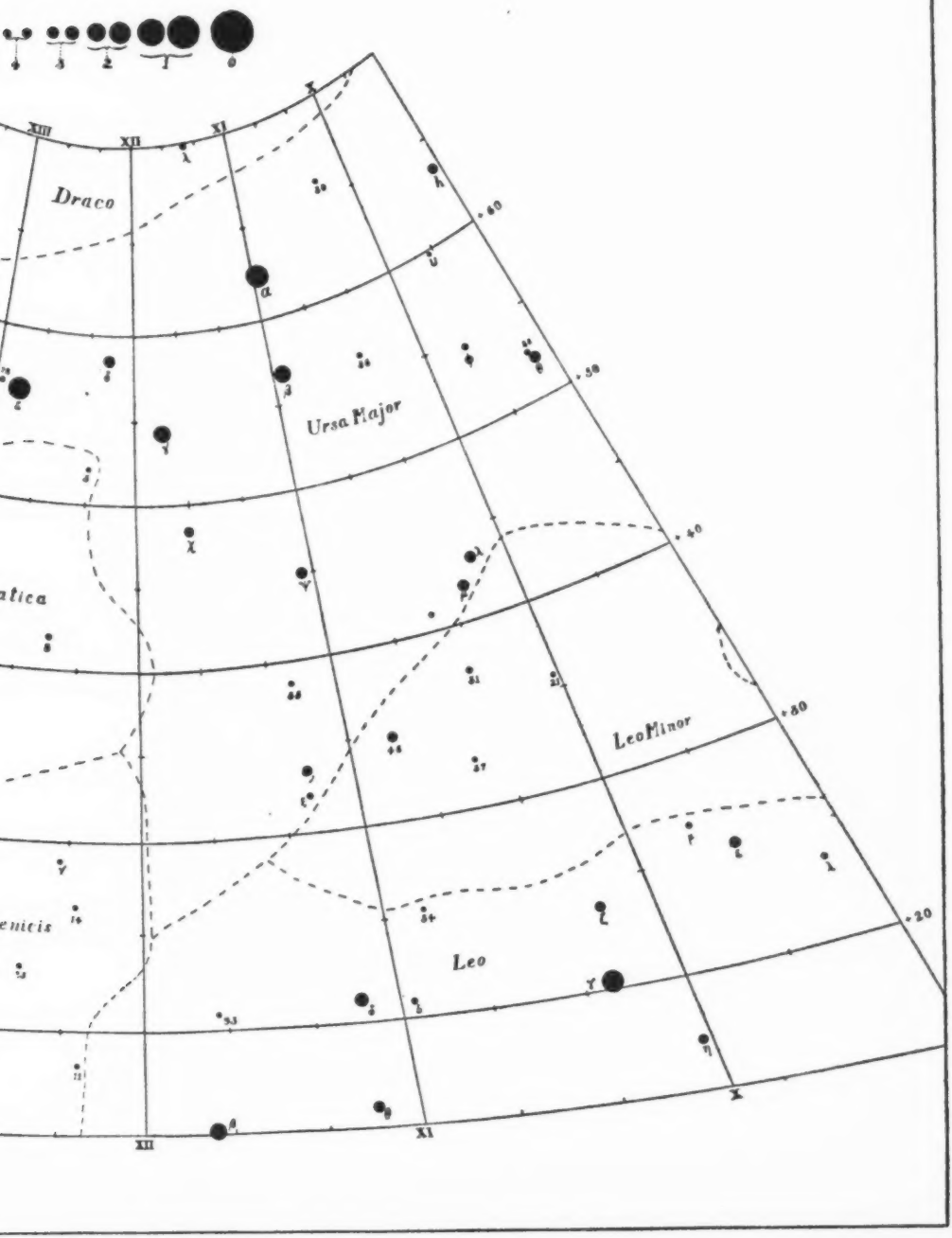

3
4
5
X
IX
+60
+50
+40
+30
+20
Ursa Major
Leo Minor
Leo
Cancer
X
IX

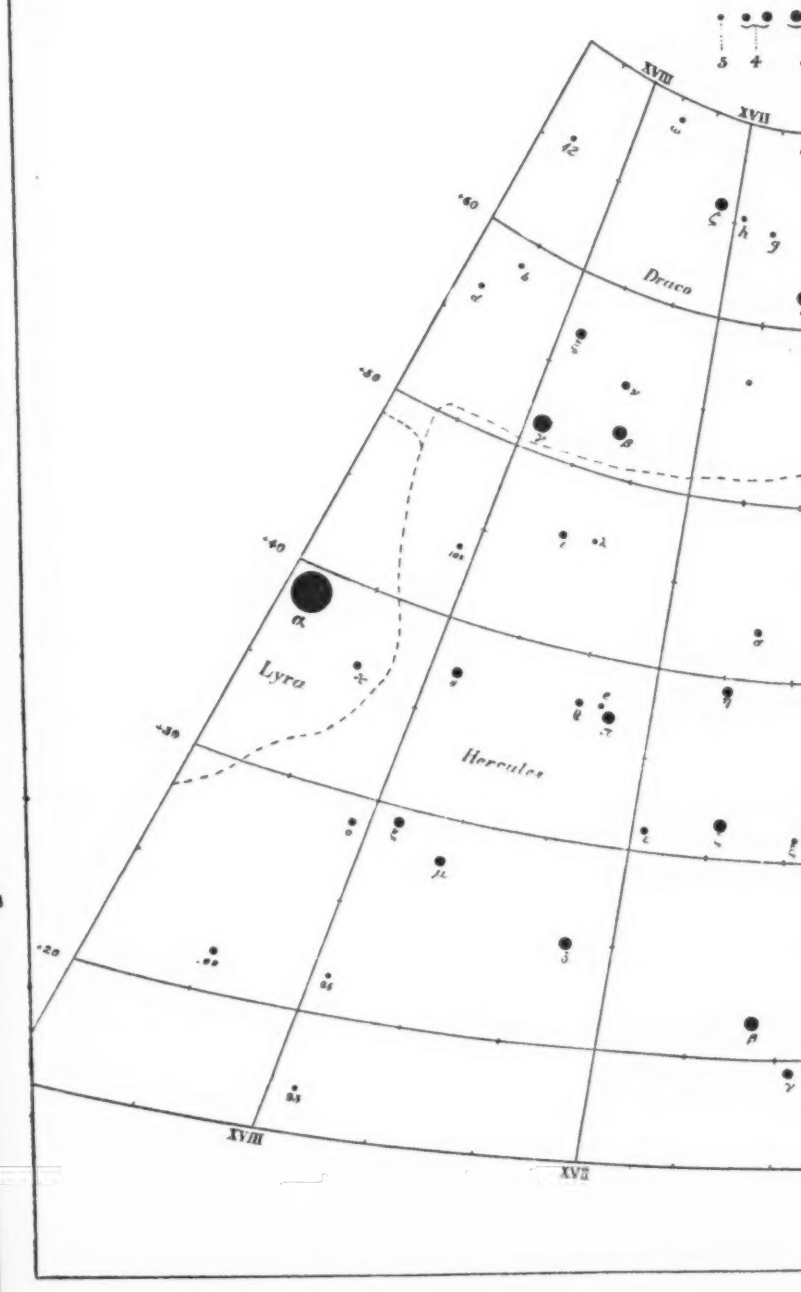
V.—A.R. VIII. hours, Decl. + 40°



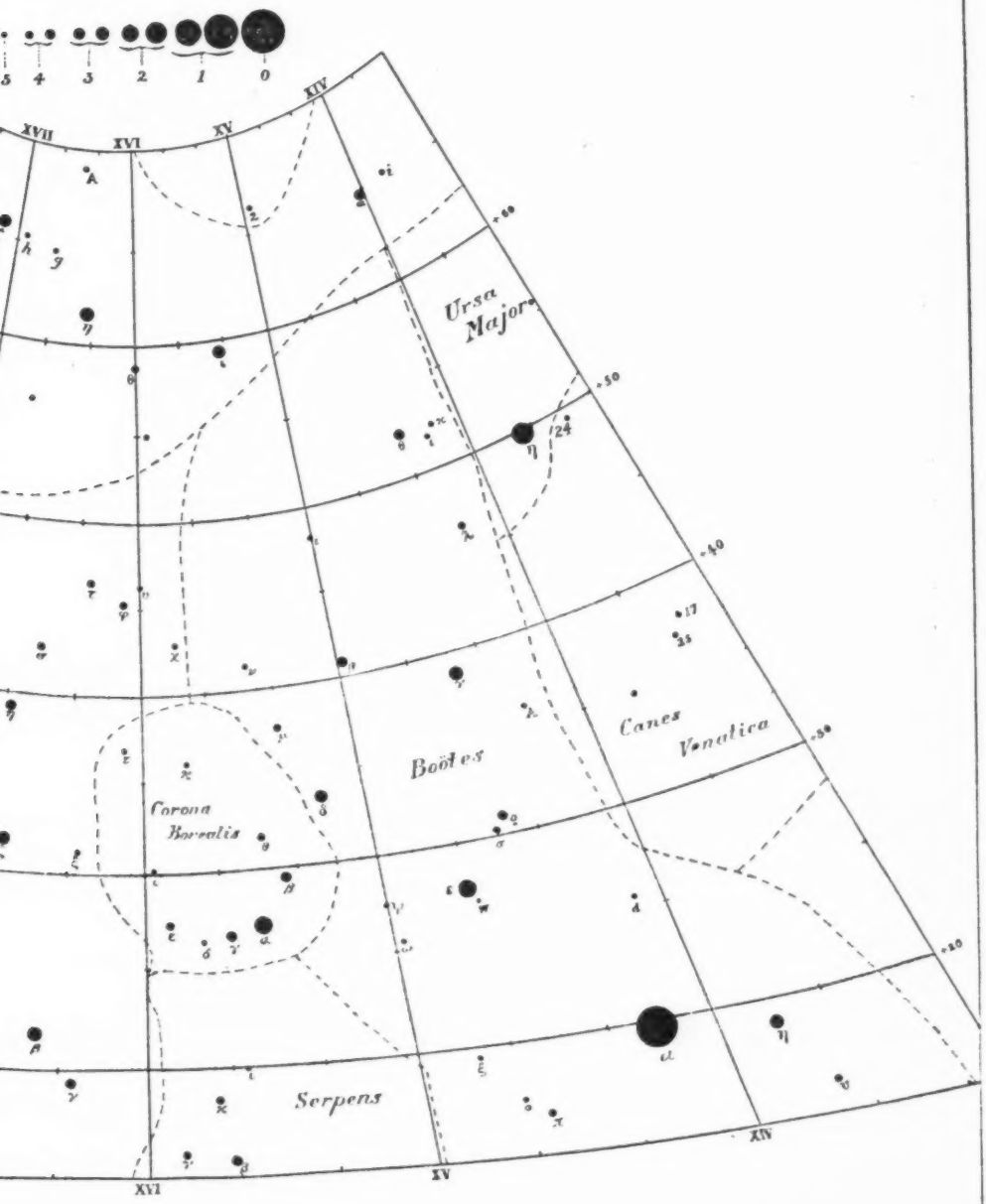

XIV
XIII
+40
+30
+40
+30
+20
Canes Venatica
Boötes
Coma Berenicis
XIV
XIII

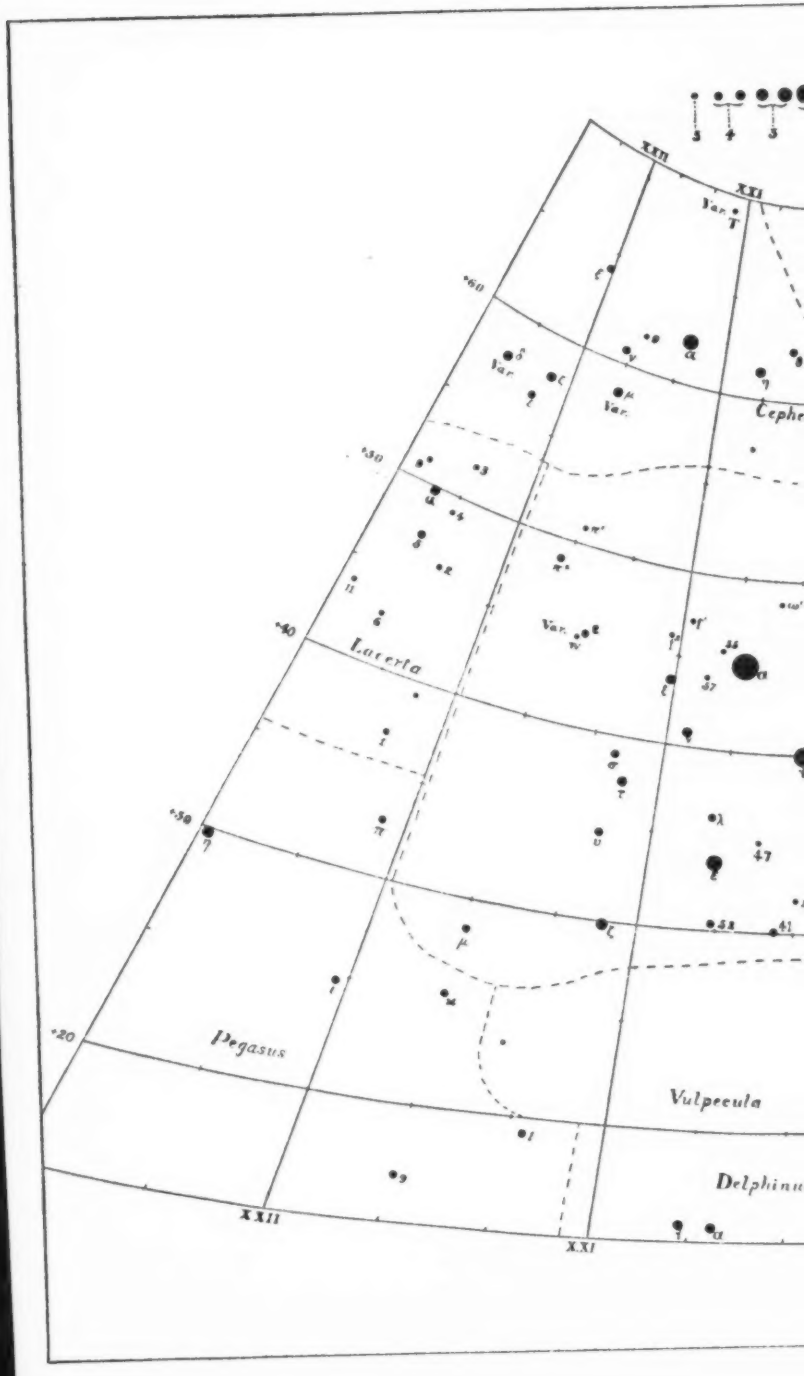
V.—A.R. XII. hours, Decl. + 40°

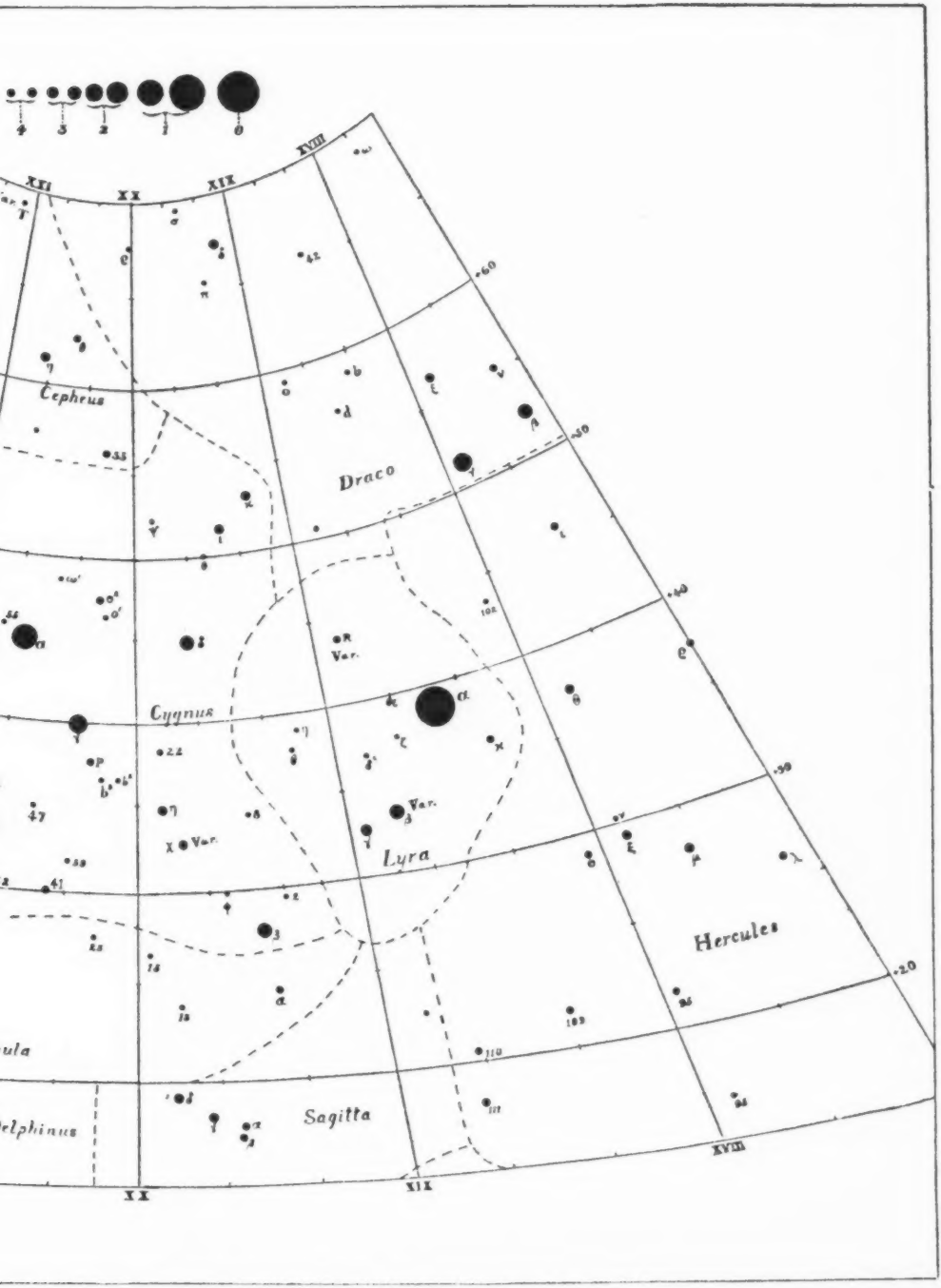


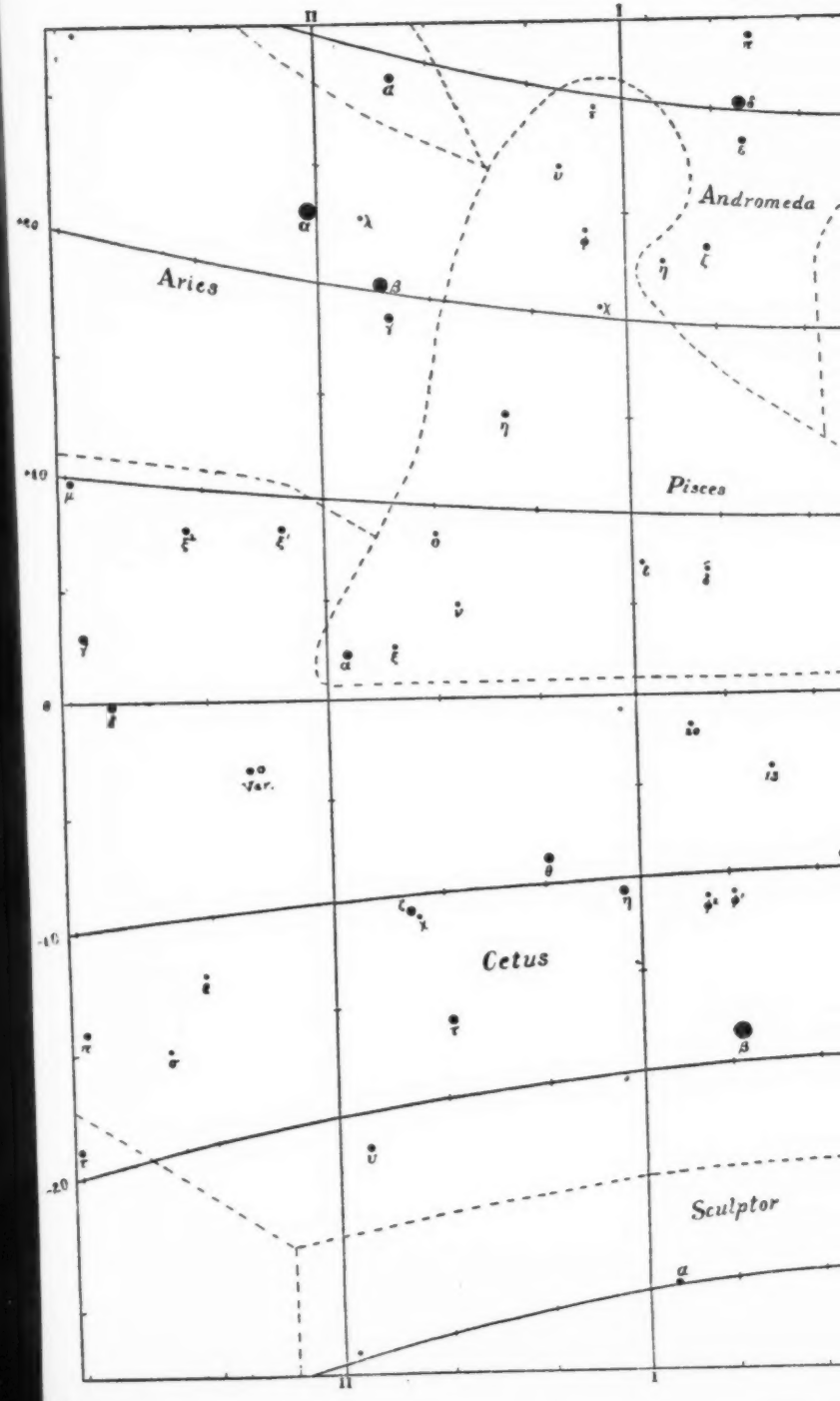

XVIII
XVII
Draco
Lyra
Hercules
+60
+40
+20
XVIII
XVII

VI.—A.R. XVI. hours, Decl. + 40°

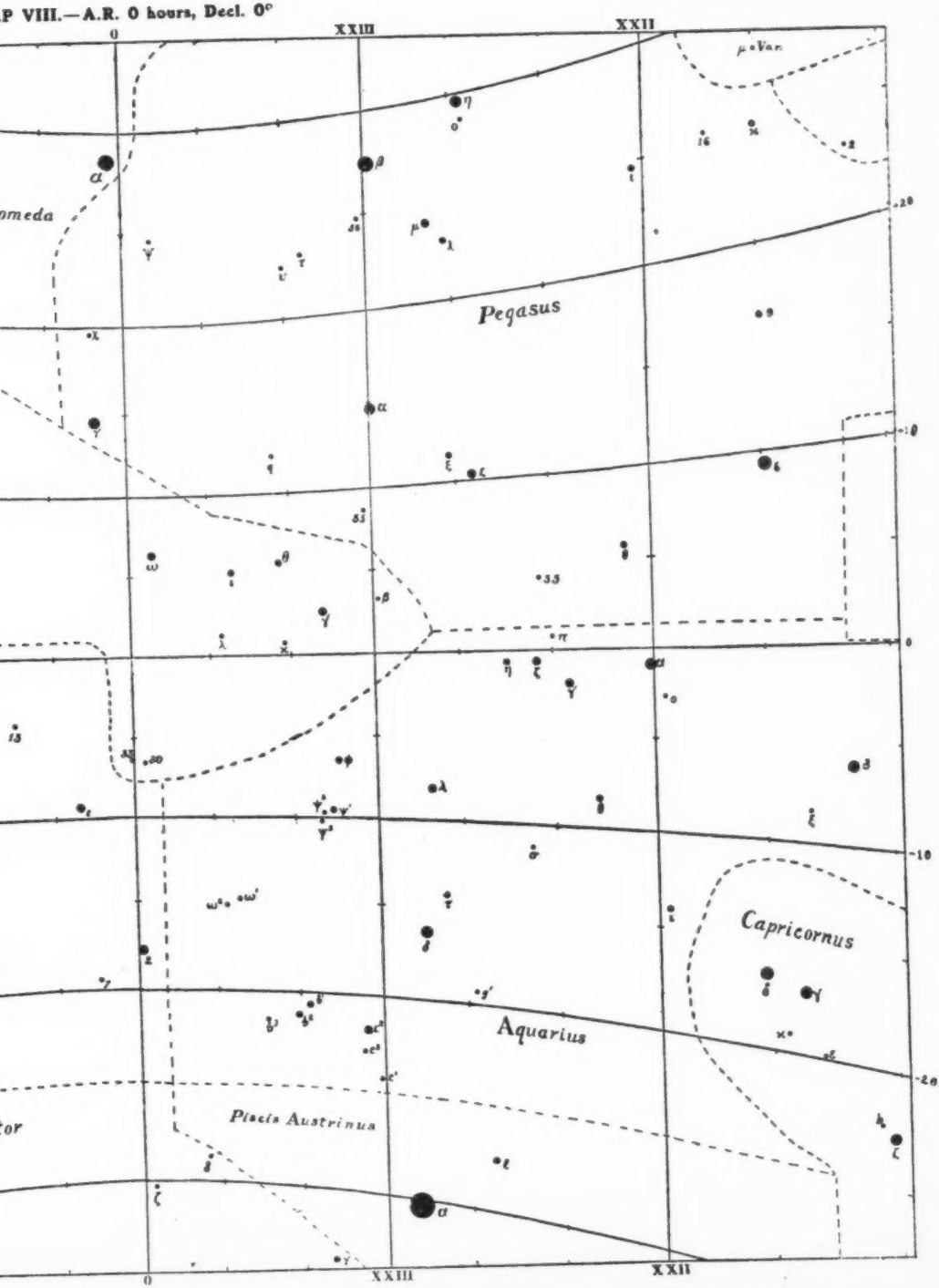


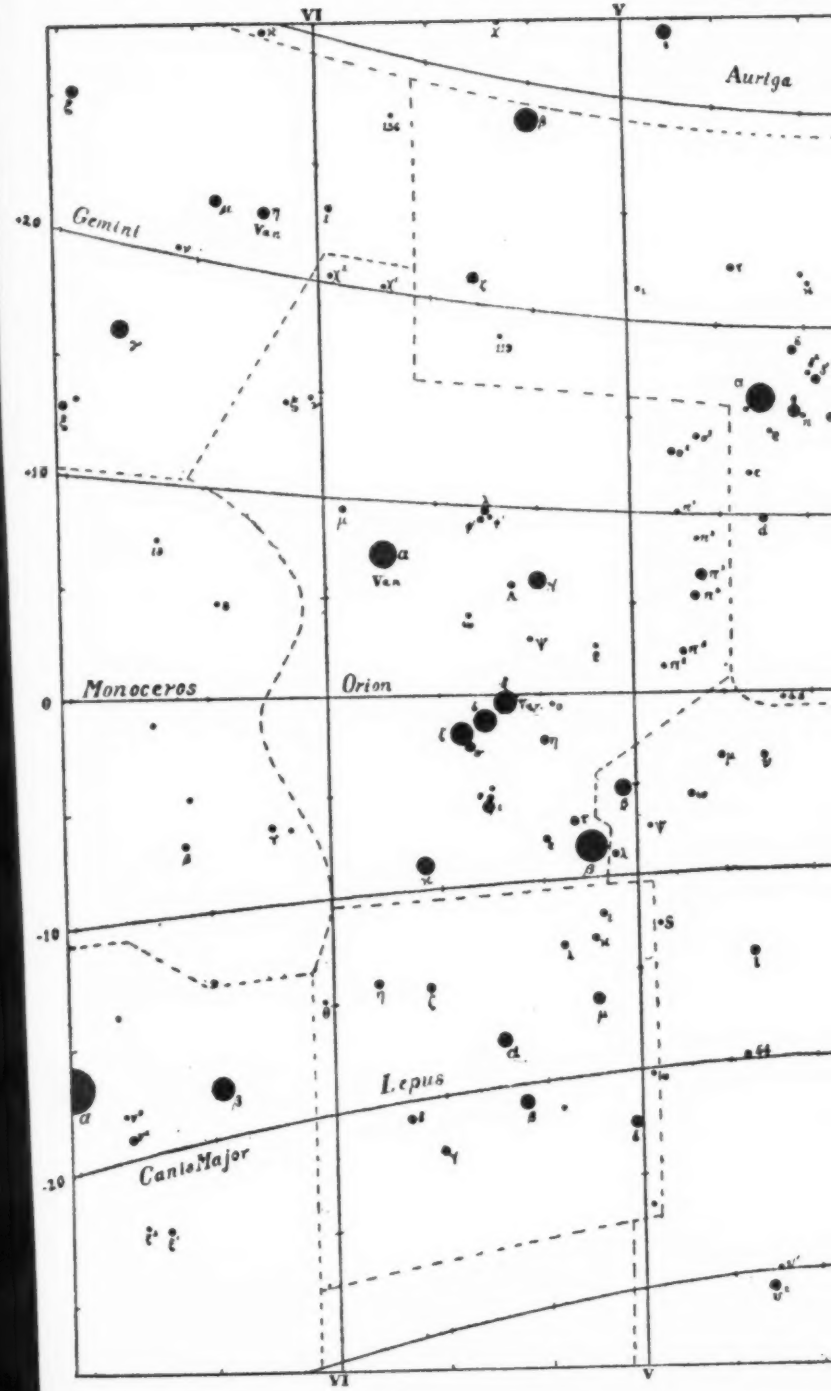

3
4
5
XXII
XXI
Var.
T
+60
Var.
Var.
Cephe
+50
+40
Lacerta
Var.
+30
47
+20
Pegasus
Vulpecula
Delphinu
XXII
XXI


4
3
2
1
0
XXI
XX
XIX
XVIII
+60
+50
+40
+30
+20
Cepheus
Draco
Cygnus
Lyra
Hercules
Sagitta
Vulpecula
Delphinus
Var.
XX
XIX
XVIII

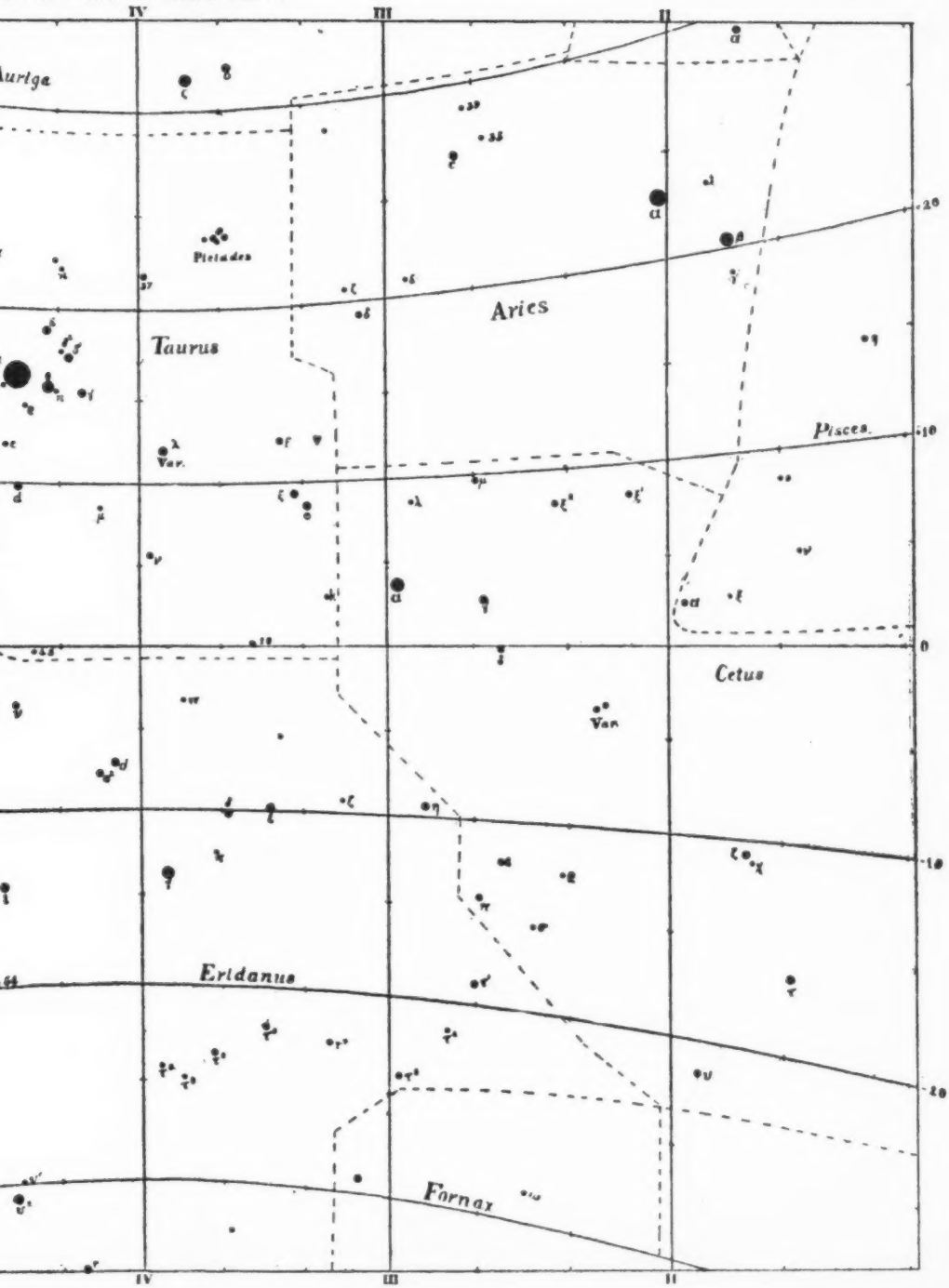

II
I
Andromeda
Aries
Pisces
Cetus
Sculptor
Var.
+20
+10
0
-10
-20
II
I

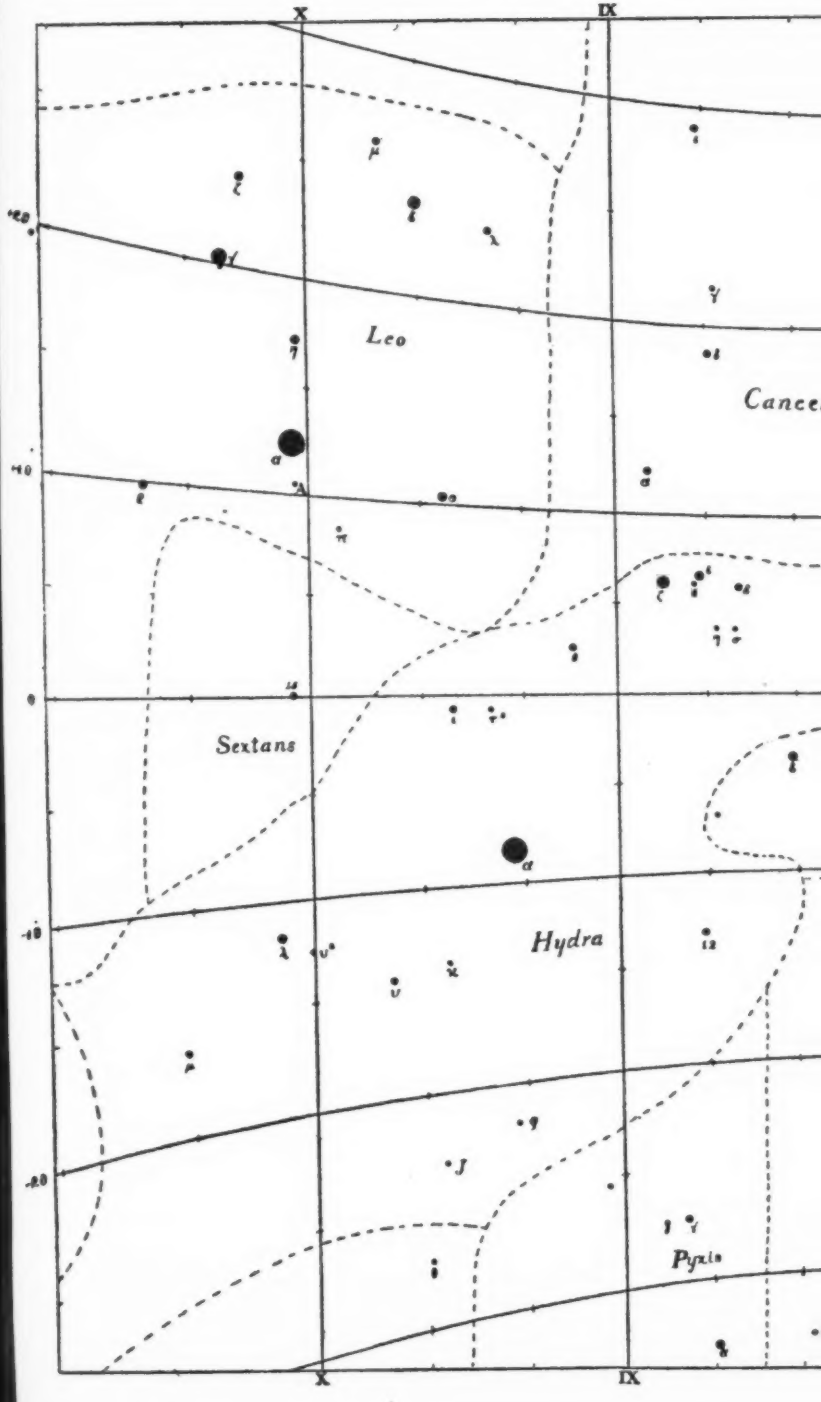
P VIII.—A.R. 0 hours, Decl. 0°



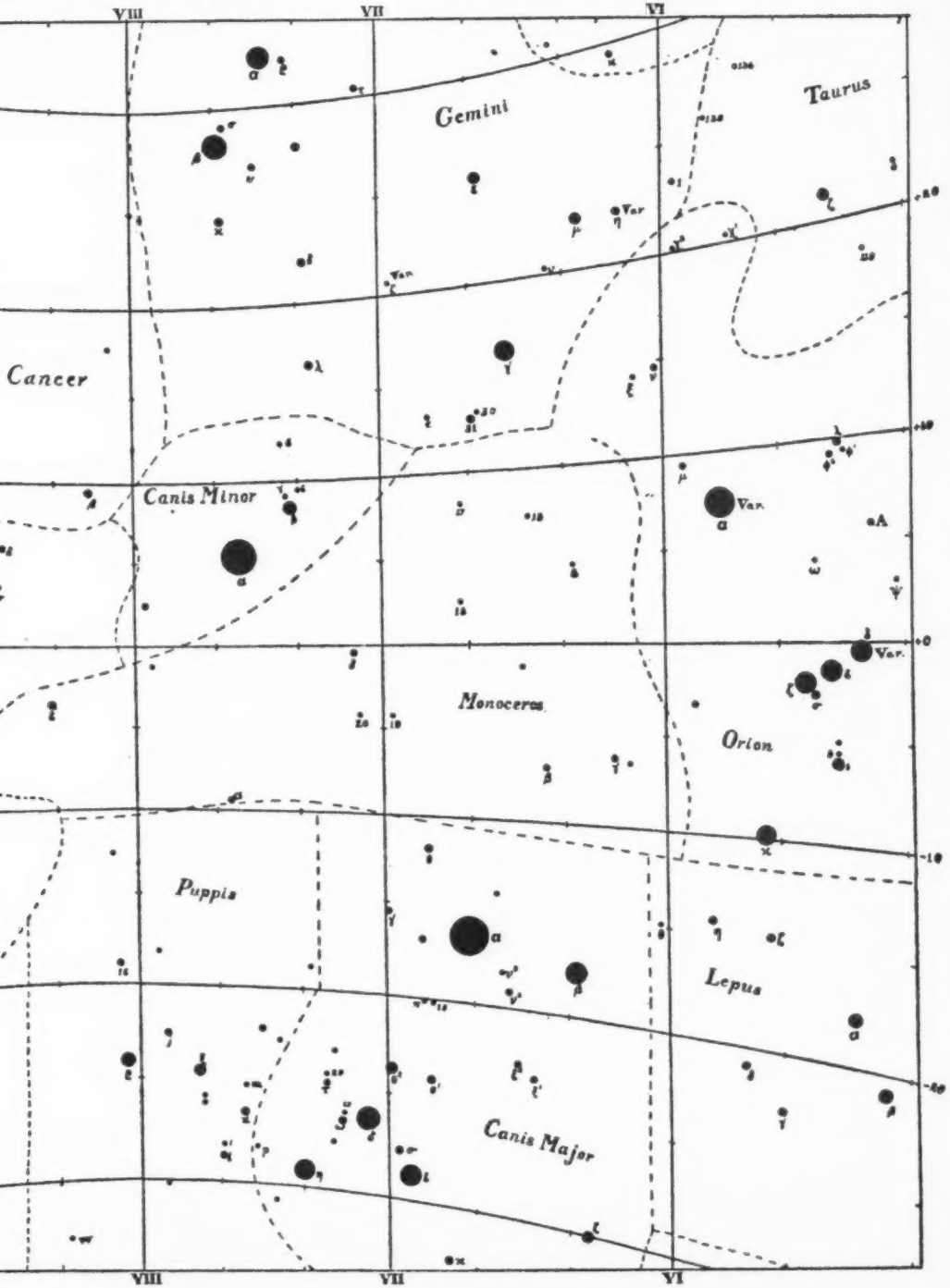

VI
V
Auriga
Gemini
+20
+10
0
-10
-20
Monoceros
Orion
Lepus
Canis Major
VI
V

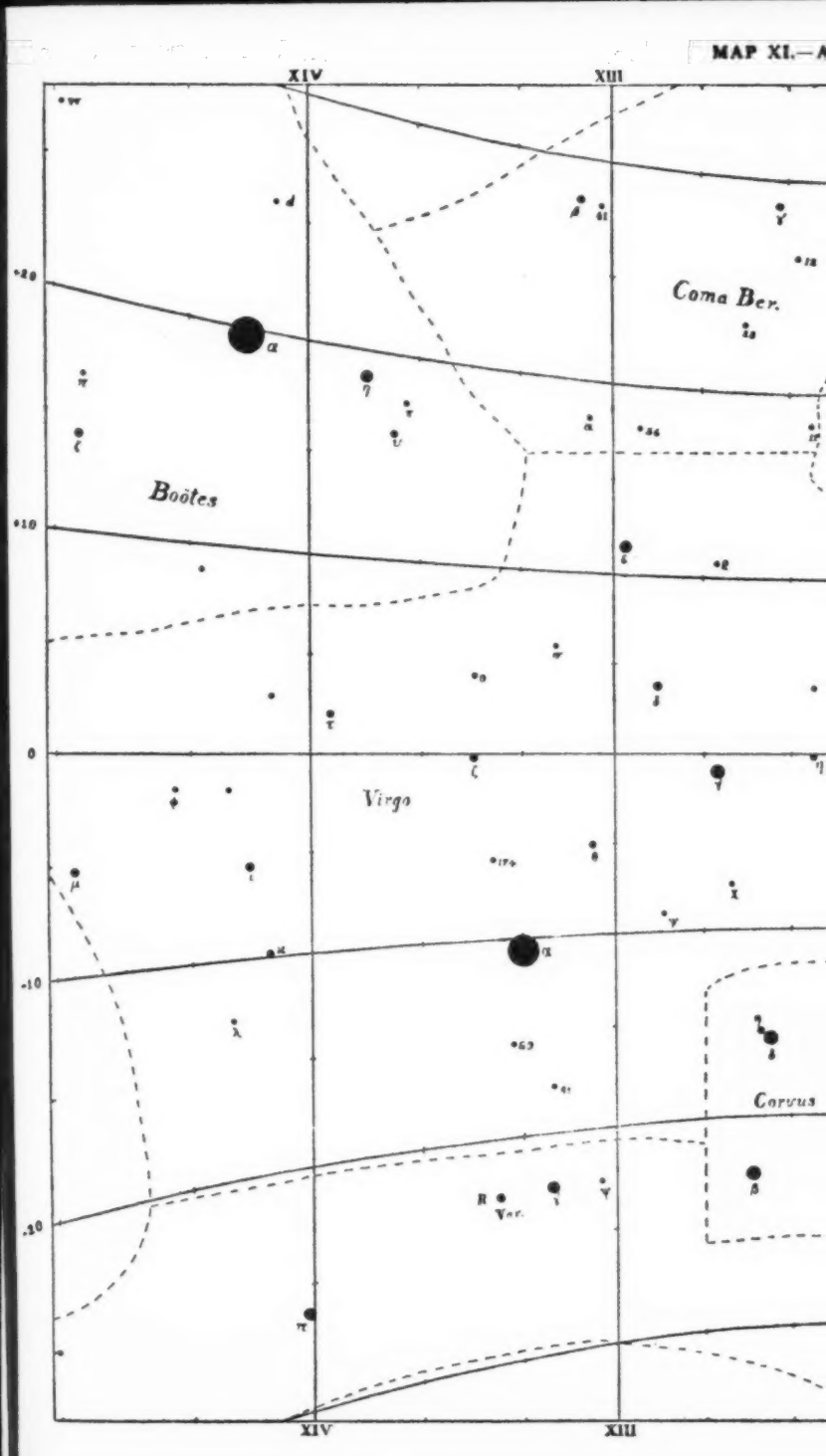
AP IX.—A.R. IV. hours, Decl. 0°



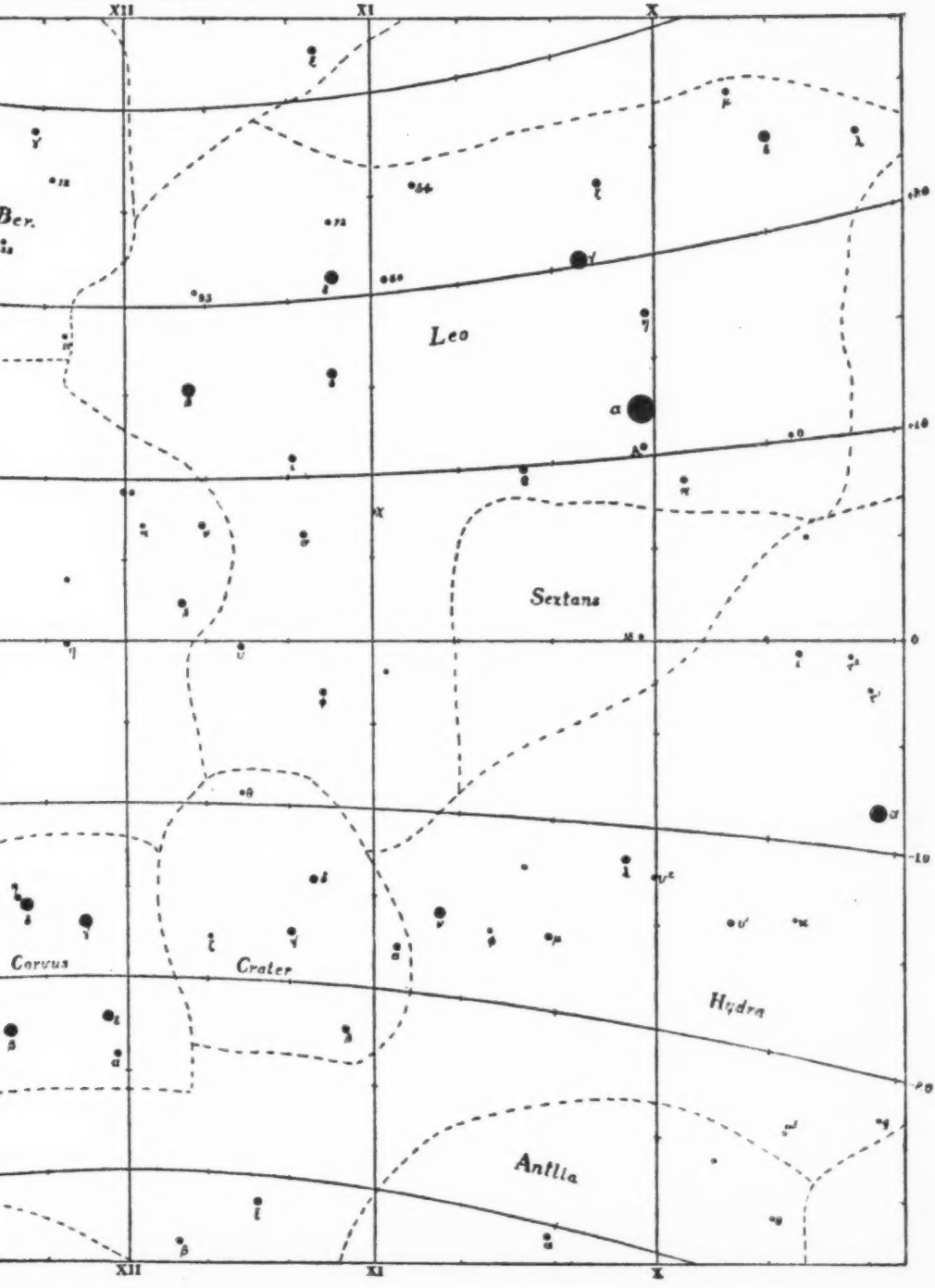

X
IX
+20
+10
0
-10
-20
Leo
Cance
Sextans
Hydra
Pyxis
X
IX

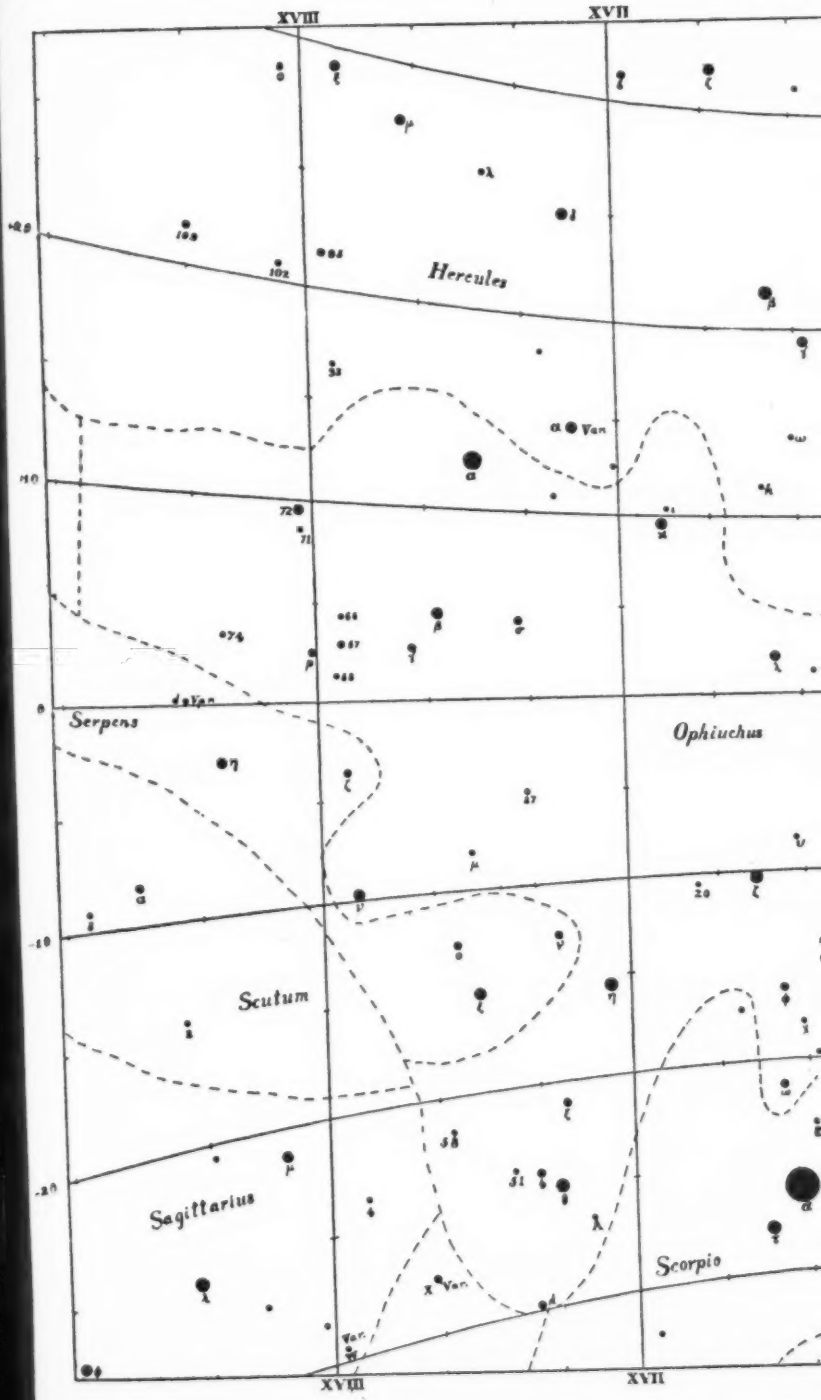
MAP X.—A.R. VIII hours, Decl. 0°



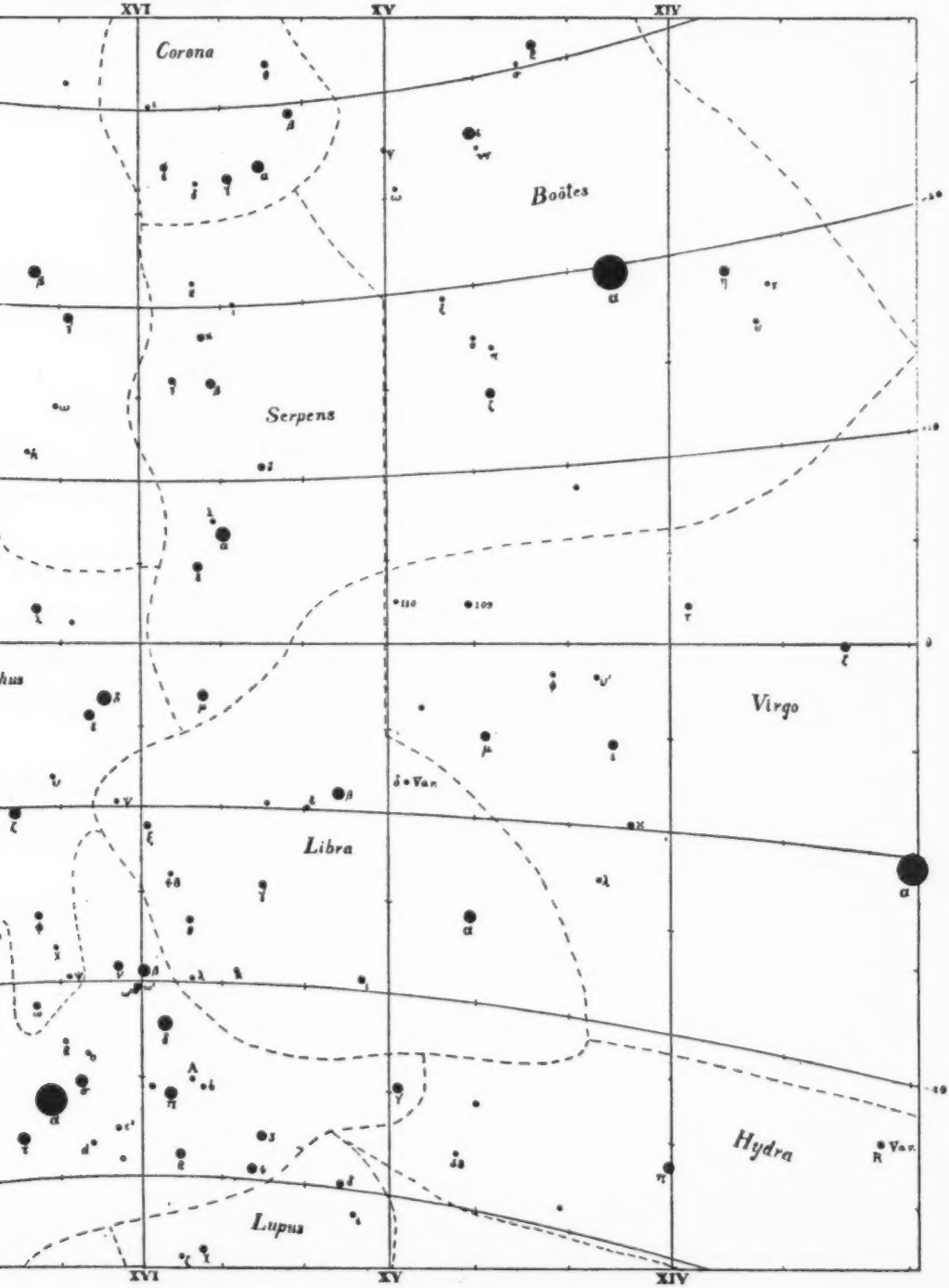

MAP XI.—A
XIV
XIII
+20
+10
0
-10
-20
Coma Ber.
Boötes
Virgo
Corvus
XIV
XIII

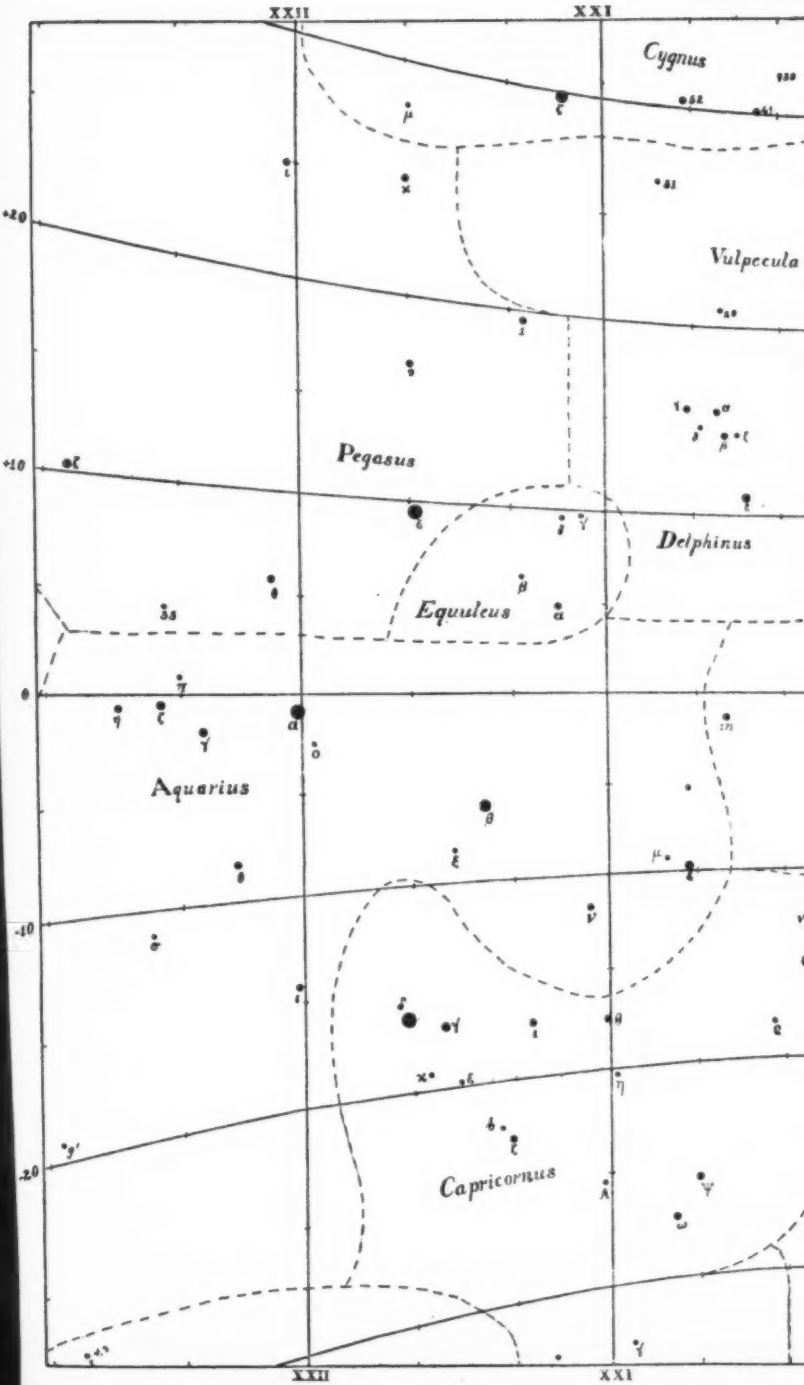
MAP XI.—A.R. XII. hours, Decl. 0°



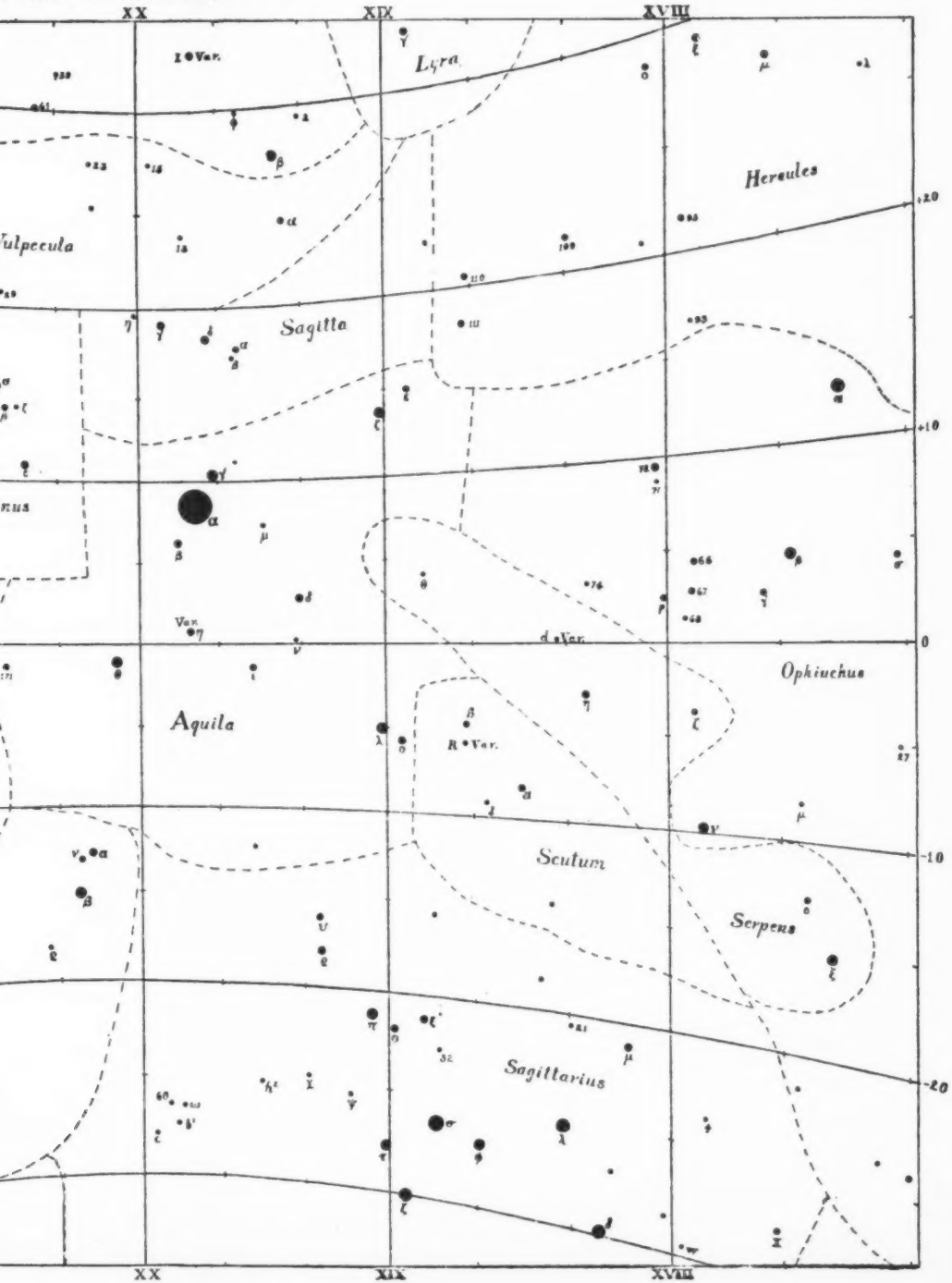

XVIII
XVII
+20
+10
0
-10
-20
Hercules
Serpens
Ophiuchus
Scutum
Sagittarius
Scorpio
XVIII
XVII

MAP XII.—A.R. XVI hours, Decl. 0°




XXII
XXI
Cygnus
Vulpecula
Pegasus
Delphinus
Equuleus
Aquarius
Capricornus
+20
+10
0
-10
-20

P XIII.—A.R. XX hours, Decl. 0°



The method of computing the position of points on the chart by means of the foregoing equations will now be illustrated by an example.

Let it be required to find the positions of $\alpha$ Arietis from the first chart of the set whose axis of projection lies at 45 degrees declination. By measurement we find $x = 3{\cdot}275$ inch s. $y = -2{\cdot}02$ inches.

Substituting these values in equation (3) log tan $(a) = 9{\cdot}7675$. Whence $a = 30°{\cdot}35$ or

$$a = 2 \text{ hours } 1{\cdot}4 \text{ minutes.}$$

Correct $\alpha$ as catalogued, 2 hours 1·5 minutes.

Either equation (1) or (2) will now serve to determine $\delta$. Substituting in (1) we obtain log cot $\delta = 0{\cdot}2743$, whence $\delta = 22° 54'$; $\delta$ as catalogued $= 22° 59'$.

The numerical co-efficients in the preceeding equations and also the measurements were computed on the basis of the width of the maps being ten inches. Owing to slight variations in the sizes of the maps, due either to errors in the photo-engraving or shrinkage in the paper, this is not the case. The observer must, therefore, measure the width of the chart he is using from outside border to border and multiply the constant 5·89 by whatever fraction of ten inches he finds the width of the map to be.

# THE PROBLEM OF ALGOL*

By Frank Schlesinger

THE first star to be recognized as variable in its light was probably Algol. The Arabs seem to have made this discovery, for it is difficult to account otherwise for the very apt name they gave the star, Algol or El Ghoul, the changing spirit or demon. The same discovery was independently made by others, among them Goodricke, of England, in 1782, when he was eighteen years of age. Goodricke continued to observe the star until he had determined the period and the nature of the light changes, and he advanced what we now know to be the true explanation of its changing light, namely that Algol is periodically eclipsed by a darker companion of nearly the same size as itself. This conjecture was a very bold one in that day, for we must remember that binary stars were then unknown. A great many double stars had been detected, but it was supposed that these were the result of perspective and chance. It was about this time that Michell showed that on the doctrine of probabilities double stars were too numerous to be fortuitous groupings in all cases, so that binary stars were in a sense discovered by a mathematician and not by an astronomer. Twenty years later Herschel proved at the telescope that some double stars are real binaries, and that they revolve around each other by reason of their mutual attractions.

In 1880 Pickering showed that Algol's changes in light conform well with the eclipse explanation, and he suggested that the matter might be settled by the spectroscope. He argued that the orbital velocity of Algol due to the attraction of the

*A portion of the Chairman's Address to Section A, (Astronomy and Mathematics), American Association for the Advancement of Science, Philadelphia, December, 1914.

dark companion should be considerable, and should change its sign according as the observations are made before or after the time of minimum light. The spectroscope was not quite ready at that time to handle problems of such delicacy, but a few years later Vogel succeeded in greatly increasing its accuracy for the determinations of velocities, by substituting the photographic plate for the human eye. Algol was among the first stars to be tested by Vogel, and his observations indicate precisely such velocities as the eclipse explanation implies. This explanation has been accepted without reserve since that time, and has been extended to all the numerous variables of the same kind that have in the mean time been discovered.

It was early noticed by Argelander and others that the period of Algol, the time between two successive light minima, is not constant. Attempts were made to represent these inequalities by formulæ involving the second and higher powers of the time, but the star refused to conform to such equations. In 1888 Chandler examined this question with great thoroughness; he showed that by the introduction of *periodic* terms all the observations up to that time could be well represented. The most important of these terms has a co-efficient of 173 minutes and a period between 130 and 140 years. To account for this Chandler supposed that the system contains a third body, and that Algol and its eclipsing companion revolve around the common centre of gravity of all three bodies in this long period. The dimensions of this orbit were supposed to be such that the light equation in it for an observer on the earth would be 173 minutes, and thus the eclipses would be advanced or delayed by this amount, according as they occur on the nearer or the farther side of this vast orbit. Chandler was quick to see that this explanation entails irregularities in the proper motion of Algol, and that these might be large enough to be unearthed from meridian observations. An examination of all the material of this kind then available convinced him that such an effect is really present, the co-efficient of the oscillation coming out 1".3, and its period 131 years. This result was apparently confirmed in a general

way by Searle at Harvard Observatory, making use of additional observations secured for this express purpose. Bauschinger, however, after applying to the catalogue positions the best available systematic corrections, concludes that there is no evidence whatever of a periodic term in Algol's proper motion. In the following year, Boss overhauled the same observations once more and decided that the probabilities were in favor of the presence of a term with a period of 131 years, but with a co-efficient much smaller than that found by Chandler, 0".5 against 1".3. In later years Boss seems to have changed his mind as to the reality of this term; for in his Preliminary General Catalogue, published in 1910, he treats Algol as though its motion were uniform, although in the case of other stars in this catalogue he devotes much attention to periodic inequalities.

It should be remarked that the absence of an appreciable periodic term in the proper motion does not necessarily imply the non-existence of Chandler's third body, since his theory does not demand any particular co-efficient for this periodic term. The only condition is that that co-efficient must be at least twenty times the star's annual parallax, and thus an accurate determination of the latter quantity would throw some light upon the present question. Unfortunately no determination of the parallax accurate enough for this purpose has as yet been made.

Starting with Chandler's inequality of 173 minutes, Tisserand has attempted an explanation that does not assume the presence of a third body. He shows that if Algol be slightly flattened and if the orbit of the eclipsing satellite be somewhat elliptical, the orbit itself will revolve slowly and uniformly in the same direction as the orbital motion of the satellite. Consequently the eclipses will occur earlier than the average time if the periastron point is in the half of the orbit that precedes eclipse, and later than the average if the periastron point is in the half that follows eclipse. This explanation is beautifully simple, and for a time seemed to be the key to the puzzle. I am able to say, not without some regret, that Tisserand's explana-

tion is no longer tenable. In his memoir the following relation is established:

Period × eccentricity = 3·1416 × the inequality. In this case the period is 2·87 days, and the inequality found by Chandler is 173 minutes; an eccentricity of 0·13 is therefore demanded, but this is out of the question. A long series of spectrographic observations made at the Allegheny Observatory shows conclusively that the eccentricity of this orbit can not possibly be as great as 0·13, that it is more likely than not to be under one-fifth this amount, and that therefore no inequality greater than forty minutes can be plausibly accounted for in this way.

Shortly after Chandler's formula for the inequality was published, the star, (always El Ghoul) thereafter began departing from it little by little, until now the eclipses occur more than an hour later than the formula implies. The character of the inequality is once more in doubt, but as the existence of some kind of inequality is beyond question, this does not lessen the necessity for an explanation.

While the chances in favor of the reality of Chandler's third body have been growing less and less, evidence has been steadily accumulating in favor of an entirely different third body in this system. Since the publication in 1890 of Vogel's classic observations, it has been well known that the radial velocity of Algol is affected by an oscillation whose semi-amplitude is about forty kilometers, and whose period is the same as that of the light changes, 2·87 days. In 1906 Belopolsky, of Pulkova, detected the presence of another oscillation in the radial velocity, the amplitude being much smaller than the other, and the period several hundred times as long. Observations made at the Allegheny Observatory have confirmed this discovery in an unmistakable way. The period of this new oscillation is found to be a little less than two years. It could be explained by the presence of a third body of such mass and so situated that the projected distance from Algol to the centre of gravity of all three bodies is about two thirds of the distance from the earth to the sun. It is natural to inquire whether other explanations are not

possible, or, in other words, whether the shifts in the spectrum lines from which this third body is inferred may not arise from other causes than changes in velocity. This disturbing question is one that frequently recurs to the mind of the astronomer. Happily, in this case it can be answered in the negative without hesitation. The presence of the third body necessitates a light equation similar to that imagined by Chandler, but now of course with a period of less than two years and with a small amplitude. This amplitude can be computed in advance; we find that it amounts to about five minutes of time. I have examined the rich photometric material on this star accumulated in the second half of the nineteenth century and have found that this light equation is actually present. This seems to leave no doubt that the shift in the spectrum lines is nothing other than an effect of velocity and that the system of Algol contains at least three bodies, only one of which is visible in even our most powerful telescopes.

It is at this point that the man at the telescope must turn to the mathematician and ask him whether this third body can in any way produce the long inequality in Algol's period, that is, in the time that elapses between successive eclipses. If this should be found not to be the case, what dynamical explanations are possible other than those already tested and rejected?

The answer to these questions would doubtless apply to other eclipsing variables, for many of these show similar inequalities in their periods, though as yet in only one other case has the presence of a third body been demonstrated.

## REVIEW OF PUBLICATION

*Publications of the Lick Observatory*, Volume XII. *Measures of Double Stars.* By R. G. Aitken.

The above publication of the Lick Observatory is the result of a carefully planned and most admirably executed programme on double stars by Professor R. G. Aitken with the 36-inch and 12-inch telescopes of that observatory. Professor Aitken began the work in 1895 and measures up to 1912 are included in the present volume. It is only fair to Professor Aitken to say that the measures therein are only a part of the observations made by him in that time. He has, in addition, carried out a systematic survey of the sky including all stars as bright as the ninth magnitude recorded in the Bonn Durchmusterung, Professor Hussey co-operating with him from 1899 to 1905. The number of close pairs so discovered surpassed all expectations, so astronomers may look forward to another treat when Professor Aitken publishes the results of this survey.

In the introduction to Volume XII. the description of instruments and methods of observation is followed by a discussion of the accuracy of the measures. The accidental errors are determined "by comparing the individual nights' results with the mean of the measures on three nights at the same epoch." From these tables it appears that the greater the separation the smaller the probable error in position angle and the greater the probable error in distance, while an increase in difference in magnitude of the components of a pair tends to increase the probable error in position angle. Also "the measures of position angle for pairs of corresponding difficulty with the two telescopes are

PLATE III.

PROFESSOR R. G. AITKEN, OF THE LICK OBSERVATORY

(In August, 1907, at the Editor's request Professor Aitken stood beside the eye-end of the 36-inch telescope, with micrometer attached, and allowed the above picture to be taken with a hand-camera.)

made as accurately with the smaller telescope as with the larger one" and "with both telescopes the measures of angle are more precise than those of distance."

From a comparison of the observed and computed places in fifty-six "fairly reliable" orbits Professor Aitken obtains average residuals of position angle and distance and from these the mean residuals are $\pm 2^{\circ}\cdot 36$ and $\pm 0''\cdot 059$ in position angle and distance respectively. Assuming that his accidental errors do not affect the size of the deviation between the computed positions and his measures, he calls the above residuals his average systematic deviation. He justifies this assumption in a decided manner by inspection of the residuals tabulated in the body of the book for each star. As in the case of accidental errors, the angular distance affects the residuals very markedly.

The orbits of over one hundred systems have been investigated and new orbits computed for twenty-six systems. Perhaps the most interesting system is that of $\epsilon$ Hydræ as both the visual and spectroscopic preliminary orbits have been determined. The period is 15·3 years and, assuming $m' : m = 0 \cdot 9$ (Seeliger), the distance between the components is 1,359,000,000 km., the distance of the pair from the sun is about 130 light-years and the mass is 3·33 of the sun's mass. $\delta$ Equulei is the next in order, having the shortest known and best determined period of any visual binary.

But in such a work where the measures are so accurate it is useless to attempt in a short review to enumerate even the most interesting points. The programme was evidently carefully chosen as there is no useless duplication of measures. Wherever the measures justify doing so, an orbit (previously computed or original) is given and a concise discussion follows or else the observer's residuals, as derived from the best determined orbits, are given. The entire absence of comment after many pairs tells us in a forcible manner that there is still an enormous amount of work to be done before these stars can be declared binaries or thrown in the discard.

R. M. Motherwell.

## MEETINGS OF THE SOCIETY

### At Toronto

*December 1, 1914.* — The meeting was held in the Rooms of the Society, 198 College Street at 8 p.m. Mr. John A. Paterson occupied the chair.

Dr. J. S. Plaskett, of the Dominion Observatory, Ottawa, President of the Society, gave the lecture of the evening on "The New Reflecting Telescope of the Dominion Observatory." Dr. Plaskett first, with the aid of diagrams, showed the essential differences between reflecting and refracting telescopes. Photographs of the disc of glass for the new reflector were shown. The disc is now being ground and figured by the John A. Brashear Co., of Pittsburgh. Diagrams were shown to illustrate the methods of using a reflector. Then diagrams of the mountings of the telescope were shown and the design and specifications were given in detail. The mounting is being constructed by the Warner & Swasey Co., Cleveland, Ohio. The work that is proposed to be carried out was outlined and photographs of the locality at Saanich Hill, near Victoria, B. C., where the telescope is to be erected, were shown.

A number of questions were asked by members present and satisfactorily answered by Dr. Plaskett.

L. G.

### At Ottawa

*November 19th, 1914.* — The third meeting of the Fall Term was held this evening in the Lecture Hall, Y.M.C.A., Mr. R. M. Stewart presiding.

Dr. J. C. McLennan, of the Univerity of Toronto, delivered the lecture of the evening on "The Constitution of the Atom."

It was explained how we arrived at the idea that matter in its various ordinary forms consists of particles whose variations in velocity produce variations in the heat given out. There were particles large enough and moving slowly enough to produce individually a marked disturbance in light thrown on them — which disturbance was visible with the aid of the ultra-microscope — the Brownian movement as it is called. The gas molecules are much smaller than these particles. The relative masses of the gas molecules could be found by chemical methods. The relative velocities of gases were shown to depend on their masses by placing various gases in electric light bulbs, and observing the speed with which the heat was conducted away from the glowing carbon filaments in the bulbs; and also by observing the speeds with which the gases passed through porous cups causing changes of pressure within. The lighter the gas molecule the more rapidly did it move. Hydrogen molecules move much more rapidly than those of oxygen or of carbon dioxide. Beyond the hydrogen particle there were still smaller particles produced by the electric discharge in gases at low pressures. A particle, called the electron, bearing a negative charge (taken as the unit charge) and having a mass about 1/1000th that of the hydrogen atom was discovered in this way; also various complexes having positive charges and varying in mass, depending on the gases from which they are formed, have been discovered. Thus the atom appears to be a complex body which under certain conditions will break up into its constituents. Many theories of this atomic structure have been put forward, each to be superseded in turn as new facts came to light. The Kelvin, Thomson, Nicholson and finally the Bohr conceptions of the atom give a vivid picture of the growth of ideas in this interesting field.

After the President had tendered the thanks of the Society to Professor McLennan for his clear and interesting address, the meeting adjourned.

*December 3rd.* — The fourth meeting of the Fall Term was

held this afternoon in the Lecture Room, Geodetic Survey Building, Mr. R. M. Stewart presiding.

Mr. W. M. Tobey, M.A., then gave his lecture on "The Geodetic Problem."

The lecturer based his remarks particularly on the triangulations in the neighborhood of Port Arthur, connecting a set of two points on the United States Coast and Geodetic Survey with a similar set of three points. The first step in the work was the making of observations connecting the first two points with the third new point — certain corrections having to be made to these observations. Then followed a second step in connecting these three points with a fourth, with a necessary new set of corrections in which the old corrections had to be modified, and so on, step following step, and correction and re-correction following of necessity until the whole system was linked up from the initial two points to the final set of three points by the most probable values of the determinations of position of the various points. Mr. Tobey pointed out how inadequate it was to make corrections for small figures and regard them as complete. It was necessary to regard all the determinations as flexible and subject to change in the light of new observations. It was also possible to state within what limits new observations must be made to be of use in correcting these positions further. By keeping the computations abreast of the observations it was possible to say what observations should be made along the various points of the network. Observers should have a good knowledge of the calculus and the theory of errors in order to choose to the best advantage the observations to be made.

In this connection Mr. Tobey has developed a new and important method by which new observations may be incorporated into the structure and their differential effects upon the old observations noted so that their total effect is the same as if all had been given a rigorous new adjustment by the method of least squares. This applies not only to new observations among the old unknowns but also to the accession of new unknowns some of which are interrelated.

After discussing some of the points of the lecture, the President tendered to Mr. Tobey the thanks of the Society. The meeting then adjourned.

*December 10th.* — The fifth meeting of the Fall Term was held this afternoon in the Lecture Room, Geodetic Building, Mr. R. M. Stewart presiding.

From a member who signed himself "A timid amateur who would like to remain unknown," a question had come to the Society as to whether the ninth satellite of Jupiter recently discovered at the Lick Observatory could possibly be the asteriod, Achilles. Dr. R. K. Young kindly answered the question and others relating to it. He showed a diagram of the orbits — very near to one another — of Jupiter and Achilles and showed that circumstances were not favorable for Jupiter to capture Achilles since it was observed in 1913. He showed that in case of capture either direct or retrograde motion of Achilles might result, depending on conditions; and if once captured there is no immediate reason to presuppose its release.

Mr. R. M. Motherwell was then called on to give his lecture on "The New Photographic Telescope." He described the doublet type of lens in which the Petzval condition was modified for astronomical purposes. Lantern slides were shown from photographs of the new telescope and of the building in which it is mounted (to the south of the main Dominion Observatory building). The mountings and adjustments of the several telescopes were clearly depicted. An 8-inch doublet, a 6-inch doublet and a 3-inch portrait camera constitute the photographic battery. Along with the 8-inch camera, two large prisms, of 15° and 25°, can be used singly or separately for photographing simultaneously the spectra of the large number of stars in the field. A slide of such a photograph showed excellent definition of the spectra of many stars. A photograph of a section of the heavens showed sharp star-images. The lenses had been tested and one refigured. Great improvement resulted in one case by spacing the lens-components slightly more. A plotted curve indicated very slight focal change for different zones. Another

curve indicated to what a great degree change of focus with wave-length had been removed. A photograph taken out of focus depicted the star-images as uniform discs which served for determining the relative brightnesses of stars. The telescope is thus capable of a wide field of observations, and much good work will follow the successful mounting and adjustment of the camera.

After some discussion the President tendered to Mr. Motherwell the thanks of the Society. The meeting then adjourned.

R. E. DEL.

### At Hamilton

*December 17, 1914.* — The Annual Meeting of the Hamilton Centre was held this evening in the Society's Rooms in the old Library Building. The Secretary's Report and the Treasurer's Report were read and the officers and executive were all re-elected by acclamation. (Fuller details will appear in the report of the Annual General Meeting of the Society).

The lecturer of the evening was Dr. C. A. Chant, who spoke on the "Aurora Borealis or Northern Lights": —

The lecturer first described the various kinds of auroræ, from the comparatively frequent kind up to the rare and wondrously beautiful coronal variety.

The lines of frequency were shown indicating that this did not increase all the way to the terrestrial pole but centred more about the magnetic pole and that the lines of frequency came further south in the western than in the eastern hemisphere. Statistics go to show that a daily maximum occurs between 6 and 12 p.m., while annually the auroræ are more numerous in April and October. There is also a secular variation corresponding with the sun-spot period. With the aid of some beautifully colored slides the lecturer described the observations of the early investigators.

Later observers were able to obtain photographs, slides from which were shown. These corroborated very fully the sketches made by the former workers.

Several theories of the cause of auroræ were discussed, one rather prevalent one being that it was caused by reflection of sun-light from the snow and ice in polar regions. Two arguments were urged against this view, *viz.*:—

1st. Reflected light would largely be polarized, no sign of which was discoverable in auroræ.

2nd. The Fraunhofer lines should be present, but they have not hitherto been observed.

The theory most generally accepted by scientists at present is the one that the aurora is due to an electric effect caused by the arrival in the earth's atmosphere of electrons ejected from the sun.

T. H. W.

## NOTES FROM THE METEOROLOGICAL SERVICE

### Summary Report of the Weather in Canada

### December, 1914

*Temperature.*—The mean temperature was below the normal over the whole of the Dominion, with the exception of a few isolated sections in Ontario where the normal was just maintained. The negative departure was very pronounced from the Great Lakes to the Pacific, and in many portions of Alberta and the interior of British Columbia amounted to from 10° to 12°. To the eastward of the Great Lakes the departures from normal were comparatively small.

*Precipitation.*—Taking the country as a whole the precipitation was much less than the normal. In some sections of the Western Provinces however, where the normal precipitation is very light, there was a slight excess, as there also was in a few localities in Ontario contiguous to Georgian Bay and Lake Huron. Over most of Ontario, Quebec and the Maritime Provinces, it was considerably subnormal.

*Depth of Snow.*—At the close of the month, snow to a depth of from four to ten inches covered the greater part of the Dominion. In Northern British Columbia the depth increased toward the interior to about thirty inches, and in New Ontario and some of the counties contiguous to Georgian Bay and Lake Huron, it ranged between ten and twenty-five inches. In Southern New Brunswick and Nova Scotia most of the country was bare, or the covering very slight.

## Temperature for December, 1914

| Station | December | | Station | December | |
|---|---|---|---|---|---|
| | Highest | Lowest | | Highest | Lowest |
| *Yukon* | | | Kinmount | 50 | -44 |
| Dawson | 19 | 32 | Kingston | 51 | -20 |
| *British Columbia* | | | Lakefield | | |
| Atlin | 30 | - 9 | London | 56 | -22 |
| Agassiz | 49 | 16 | Lucknow | 51 | -15 |
| Barkerville | 32 | 8 | Madoc | | |
| Kamloops | 45 | 2 | Midland | 62 | -30 |
| New Westminster | 49 | 18 | North Gower | | |
| Prince Rupert | 47 | 20 | Ottonabee | | |
| Vancouver | 49 | 21 | Ottawa | 45 | -24 |
| Victoria | 49 | 30 | Owen Sound | | |
| *Western Provinces* | | | Paris | 56 | -17 |
| Battleford | 33 | 28 | Parry Sound | 51 | -24 |
| Broadview | | | Peterboro' | 53 | -29 |
| Calgary | 38 | 10 | Port Arthur | 44 | -20 |
| Carman | | | Port Burwell | 55 | -22 |
| Edmonton | 34 | -20 | Port Dover | 53 | -21 |
| Medicine Hat | 42 | -12 | Port Stanley | 54 | -25 |
| Minnedosa | 25 | -32 | Renville | 49 | -38 |
| Moose Jaw | 41 | -30 | Sarnia | | |
| Oakbank | 28 | -32 | Southampton | 53 | - 2 |
| Portage la Prairie | 25 | -26 | Stonecliffe | 43 | -40 |
| Prince Albert | 22 | -40 | Stony Creek | 59 | -14 |
| Qu'Appelle | 26 | -36 | Stratford | | |
| Regina | 30 | -35 | Toronto | 54 | - 7 |
| Swift Current | 42 | -16 | Uxbridge | 56 | -26 |
| Winnipeg | 29 | -27 | Wallaceburg | 65 | -17 |
| *Ontario* | | | Welland | 53 | 15 |
| Agincourt | 52 | 12 | White River | 41 | -46 |
| Aurora | 52 | -22 | *Quebec* | | |
| Bancroft | 50 | -40 | Bromc | 57 | 32 |
| Barrie | 53 | -19 | Father Point | 44 | 13 |
| Beatrice | 50 | -32 | Montreal | 48 | -16 |
| Birnam | 50 | 14 | Quebec | 44 | -23 |
| Bloomfield | 54 | -25 | Sherbrooke | 54 | -27 |
| Brantford | 57 | -22 | *Maritime Provinces* | | |
| Bruce Mines | | | Charlottetown | 47 | - 9 |
| Chatham | 59 | -10 | Chatham | 49 | -24 |
| Clinton | 53 | -10 | Dalhousie | 40 | -15 |
| Cottam | 59 | -17 | Fredericton | 47 | -22 |
| Gravenhurst | 52 | -38 | Halifax | 55 | -14 |
| Guelph | 55 | -11 | Moncton | 53 | -13 |
| Haliburton | 49 | -38 | St. John | 49 | 10 |
| Hamilton | 55 | - 6 | St. Stephen | 54 | -28 |
| Huntsville | 47 | -34 | Sussex | 52 | -17 |
| Kenora | 38 | -30 | Sydney | 51 | 4 |
| | | | Yarmouth | 53 | 6 |

# ITALIAN EARTHQUAKE, JANUARY 13, 1915

## DATA FROM OTTAWA RECORD

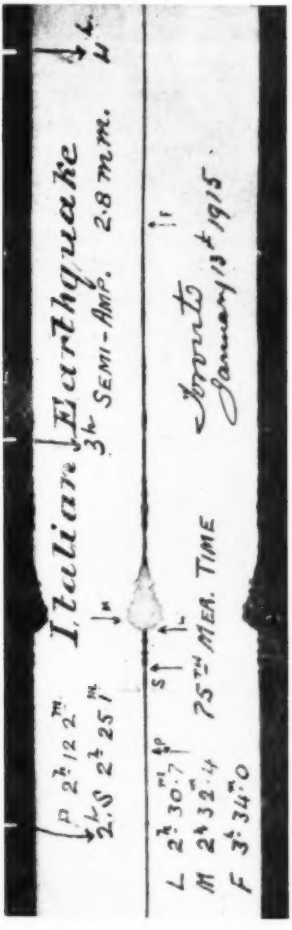
DISTANCE TO EPICENTRE 6860 KM. (4300 MILES).

| | h | m | s | |
|---|---|---|---|---|
| Arrival of Longitudinal (P) Waves | 7 | 02 | 57 | G.M.T. |
| Arrival of Transverse (S) Waves | 7 | 11 | 49 | G.M.T. |
| Arrival of Second Reflected Transverse (SR2) Waves | 7 | 18 | 08 | G.M.T. |
| Arrival of Long (L) Waves | 7 | 20·5 | | G.M.T. |
| End (E) | 8 | 00 | | G.M.T. |
| Time of Transmission P Waves | | 10m | 198·9 | |

All Italian Earthquakes have a shallow hearth; only a few kilometres beneath the surface.

OTTO KLOTZ.

DOMINION OBSERVATORY,
January 21, 1915




RECORD OF THE ITALIAN EARTHQUAKE MADE BY MILNE SEISMOGRAPH AT THE METEOROLOGICAL OBSERVATORY, TORONTO

## Earthquake Records by the Milne Seismograph

### TORONTO

R. F. Stupart, Director

P. T. = Preliminary Tremors. L.W. = Large Waves. A.C. = Air Currents.
Time is Greenwich Civil Mean Time, 0 or 24 h = midnight.

| No. | Date 1914 | | P. T. Comm. | L.W. Comm. | Max. | End | Max. Amp. | Durat. | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | h m | h m | h m | h m | mm | h m | |
| 1417 | Dec. | 3 | 0 12·1 | 0 23·4 )<br>0 29·8 ) | 0 33·5 )<br>0 53·0 ) | 1 37·4 | 0·2<br>0·2 | 1 25·3 | Apparently two [quakes. |
| 1418 | " | 4 | A.C. | 22 24·8 | | A. C. | | | A. C. going on. |
| 1419 | " | 15 | 9 28·4 )<br>9 30·4 ) | 9 53·2 | 9 57·5 | 10 39·8 | 0·3 | 1 11·4 | P. doubtful. |
| 1420 | " | 20 | 14 34·1 | 14 51·4 | 15 10·8 | 16 15·2 | 0·7 | 1 41·1 | Marked move- |
| 1421 | " | 20 | 16 19·0 | 16 30·7 | 16 34·8 | 16 52·5 | 0·2 | 0 33·5 | [ments. |
| 1422 | " | 25 | 3 44·4 | 3 54·8 | 3 56·7 | 4 27·4 | 0·3 | 0 43·0 | |
| 1423 | " | 27 | | 7 49·4 | | 7 52·7 | 0·05 | 0 3·3 | |

Period 18 seconds. Pillar inclination 1 mm. = 0″·59.

### VICTORIA, B. C.

F. N. Denison, Superintendent.

| No. | Date 1914 | | P.T. Comm. | L.W. Comm. | Max. | End | Max. Amp. | Durat. | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | h m | h m | h m | h m | mm. | h m | |
| 1429 | Dec. | 3 | 0 32·4 | 0 38·4 | 0 39·9 | | 0·2 | | Appears to be two [quakes. |
| 1430 | " | 3 | 1 30·1 | 1 09·4 | 1 10·9 | | 0·2 | | |
| 1431 | " | 4 | 22 27·5? | 22 28·0 | 22 28·3 | 22 34·0 | 0·5 | 0 06·5 | |
| 1432 | " | 15 | 9 36·1 | 9 38·1? | 9 40·7 | 9 49·1 | 0·3 | 0 13·0 | |
| 1433 | " | 20 | 14 30·4 | 14 45·3 | 14 48·7 | 15 51·3 | 1·3 | 1 20·9 | |
| 1434 | " | 20 | 16 28·8 | 16 38·3 | 16 39·8 | 16 58·8 | 0·3 | 0 30·0 | |
| 1435 | " | 25 | | 4 10·7 | | 4 21·4 | 0 05 | 0 10·7 | |
| 1436 | " | 27 | 7 54·1? | | 7 58·1 | 8 13·1 | 0·2 | 0 19·0 | |

Period 18 seconds. Pillar inclination 1 mm. = 0″·54

J. Y.

## MAGNETIC OBSERVATIONS

During the month of December, 1914, small disturbances were recorded from the 4th to 10th, 16th to 19th, on the 22nd and 24th and from the 27th to 31st. The only disturbance of note occurred on the 28th.

The Declination Curve shows the beinning of disturbance at about 11 a.m. of the 27th, marked by small rapid vibrations, which gradually changed during the afternoon to waves of long period which reached their maximum amplitude about 4 a.m. of the 28th, and then slowly returned to normal. In Horizontal Force the movements are of a similar nature, the duration of the disturbance rather than its magnitude being the chief characteristic. In the Vertical Force Curve, very small movements are noticeable about noon of the 27th, and then the disturbance had the effect of gradually diminishing the Vertical Force until the minimum was reached shortly after 4 a.m. of the 28th, after which the curve gradually assumed its normal position.

The accompanying table gives the values of the different magnetic elements for the month.

| December, 1914 | | D. West | H | V | I |
|---|---|---|---|---|---|
| | | ° ′ | | | ° ′ |
| | Mean of Month | 6 26·5 | 0·16056 | 0·58699 | 74 42·1 |
| | Maximum | 6 39·9 | 0·16081 | 0·58714 | |
| | Date of Maximum | 28 | 16 | 28 | |
| | Minimum | 6 11·9 | 0·15982 | 0·58679 | |
| | Date of Minimum | 7 | 28 | 28 | |
| | Monthly Range | 0 25·0 | 0·00099 | 0·00035 | |
| Mean Daily Amplitude | δ From hourly readings | 0 5·8 | 0·00023 | 0·00005 | |
| | δ From Means of Extremes | 0 9·1 | 0·00036 | 0·00011 | |

H and V are expressed in C. G. S. Units.

I is the Mean of all Dip observations made during the month with the Earth Inductor, without regard to the time of day at which they were made. Two observations are usually made each week.

## ASTRONOMICAL NOTES

METEOROLOGY IN WAR.— It is by no means surprising that for their raid on the three British coast towns the Germans should have profited so accurately by climatic conditions. When they first entered Belgium their army corps were immediately followed by the full staff of their observatories. On August 16 the astronomers and meteorologists attached to the Aix-la-Chapelle army corps took up their quarters at Liège, and on August 25 they were all at the Brussels Observatory at Uccle, where, on September 1, they were replaced by astronomers and meteorologists from Berlin.

Immediately on arriving at the Brussels Observatory the Germans turned out the Belgian staff. They made use of the Belgian instruments but supplemented them by the very up-to-date instruments they had brought from Berlin. On September 3 they began hunting for a Belgian hydrogen factory where they could obtain hydrogen for filling their testing balloons, by means of which they make their observations for predicting fogs. They used these balloons for forecasting the weather, particularly for the great German attack on Antwerp.

There is abundant evidence that the German men of science followed the same course with regard to the German raid on Scarborough, Hartlepool, and Whitby. They are admirably equipped for forecasting fogforty-eight hours ahead wherever they are. The German Army meteorological stations have certainly been transferred to Ostend and Zeebrugge. They may not be as important as submarines, but these observation stations can render almost as effective aid in Germany's work of destruction as these engines.—*Nature*, No. 2356.

THE PLANET JUPITER.—Some reference to the present appearance of the planet may be of interest. A comparison of the drawings of 1913 with those of the current apparition shows that considerable changes have been in progress, and illustrates those characteristics of the surface markings which render Jupiter so attractive an object for telescopic scrutiny. The South Tropical Disturbance is now clear of the Red Spot Hollow, having just completed its sixth conjunction with that object, and the Red Spot itself has once more emerged as a well defined ellipse.

Marked changes have occurred in the north equatorial, north tropical, and north temperate regions of the planet. The brilliant egg-shaped markings which in 1913 formed a belt round the north part of the equatorial zone have become degraded into smaller and less regular white areas, whilst the dark protuberances are also very unequal in size, shape and distance apart. Observations of thirteen north equatorial markings down to the end of August give a mean rotation-period of 9h 50m 17s·4, which is a slight increase on the value of last year.

Amongst recent developments must be mentioned the formation of dark spots on the north component of the north equatorial belt with white intermediate areas (some of them very bright) on the region between the two components of the belt. Still more interesting is the form assumed by some of the dark markings. They are distinctly arched to the south, and enclose small brilliant white spots, the appearance being suggestive of bridges, or sometimes links of a chain. At least seven objects are of this character. Observations of seventeen objects in this region show the rotation-period down to the end of August to have been 9h 55m 30s·6.

Another striking difference between the appearance of the planet in 1913 and 1914 is furnished by the south equatorial belt. Almost uniformly dark in the former year, it has recently consisted of two widely separated bands with a pale orange region between them.—REV. T. E. R. PHILLIPS, *Knowledge*, No. 556.

J. R. C.

## NOTES AND QUERIES

**Communications are Invited, Especially from Amatuers. The Editor will try to Secure Answers to Queries.**

### QUERY

In the HANDBOOK for 1914, I find the following entry:—

December 20, 20h 32m ♂ ☌ ☾, ♃ 0° 12′ S.

Now the moon's semi-diameter is greater than 12′ and so there should be an occultation of Jupiter. Was there an occultation?—Amateur, (Toronto).

### ANSWER

By Mr. R. M. Motherwell, Dominion Observatory, Ottawa:

The chart used at Ottawa in predicting occultations shows in each case the path of the observer and that of the moon's shadow, as projected on a plane perpendicular to the light of the star.

In the case of Jupiter on December 20, 1914, the path of the moon's shadow passed to the south of the observer's path (at Ottawa or Toronto); hence no occultation. Furthermore, it is very seldom that an immersion in the west can be observed unless the semi-diurnal arc of the star is at least one hour greater than the local hour angle of conjunction. In the case in question this difference was less than ten minutes, so the occultation would not have been visible even if the moon's shadow had not been too far south.

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### THE CENTRES OF THE SOCIETY

At the recent Annual General Meeting of the Society, the minutes of which will appear in our next issue, the reports from the various Centres showed that the Society as a whole is in a healthy condition, although one or two places seemed to be not

as active as they might be. The present writer learns that the Centres referred to are taking steps to push our cause more vigorously during the present year.

A discussion took place regarding the allowances to be made to the Centres by the General Council for carrying on the work, and it was unanimously agreed that, under ordinary conditions, the income from the Centre should cover all ordinary expenses of the meetings there. With the assistance of the Government grants the JOURNAL and HANDBOOK are published and these are supplied to each member, but it is evident to all that each Centre should be self-sustaining. It should not be a permanent charge on the General Funds of the Society.

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## ASTRONOMICAL PERSONALS

At New Year's, the honor of knighthood was conferred on Frank Watson Dyson, Astronomer Royal since 1910.

N. C. Dunér, the distinguished Swedish astronomer, Secretary of the Swedish Royal Society of Sciences, died on November 10, 1914, at the age of 75 years. Perhaps Dunér's best known work was his spectroscopic determination of the rotation periods of the sun (1891-1906).

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## THE ORIONID AND GEMINID METEORIC SHOWERS

By reference to the OBSERVER'S HANDBOOK, page 50, it will be seen that the duration of the Orionids is given as October 9 to 29, the greatest display being on October 19; the duration of the Geminids is December 1 to 14, with greatest display on December 11.

Under date December 17, 1914, Mr. W. F. Denning, of Bristol, England, writes:

This year we were favored, as regards absence of moonlight, for the observation of these streams, but the weather proved extremely cloudy and few meteors could be recorded. The Orionids were recognized on one night only and the Geminids on three, the radiants being:—

| | | |
|---|---|---|
| October | 25 ... | 91° + 14½° |
| December | 8 ... | 105 + 31 |
| December | 12 ... | 109 + 33 |
| December | 15 ... | 114 + 33 |

The latter shower exhibits a decided shift in the place of the radiant and confirms my observations of 1885. It is evidently a double shower on December 12 with radiants at 109 + 33 and 119 + 32. These positions were also recognized in 1885 and 1892 when slight differences due to observational errors are allowed for.

The weather here is frequently cloudy and it is not a rare experience for a shower, extending over several nights, to elude detection. There are periods, it is true, when atmospheric conditions are splendid, as in the summer seasons of 1887, 1893, 1899 and 1911. In the latter year July and August (62 days) furnished no less than 58 nights either clear or partly clear.

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## AN ASTRONOMER ON PAINTING AND POETRY

At the recent meeting of the American Association for the Advancement of Science, at Philadelphia, Director Frank Schlesinger, of the Allegheny Observatory, gave an instructive and entertaining address on "The Object of Astronomical and Mathematical Research." Dr. Schlesinger spoke as Vice-President and Chairman of Section A., Astronomy and Mathematics, and he made a strong appeal for greater co operation between these two great branches of science. The astronomer and the mathematician were both urged not to live too much to himself, nor to give himself over to the technique of his subject. A portion of the address appears on another page of this issue under the title, "The Problem of Algol." In emphasizing the difference between the technique of a subject and its true inner nature the following reference was made to painting and poetry, which the present writer thinks worth reprinting:

This difference in view-point is nothing more than a recurrence of the struggle that occurs in every kind of human activity between the essentials of a subject and the technique of that subject. It is a remarkable fact that the outcome of this struggle is not always in favor of the former, but that mere technique is sometimes able to gain permanent mastery and to submerge completely the objects for which it was created. The best illustration of this is to be found in the painter's art. We know that there was a time when painting was regarded as a mode of expression through which lessons might be taught and learned, or through which at least the world might be amused. But for many a long day painters have refused to take this view of their art. They hold in frank contempt a picture that tells a story, and their standards of what constitutes a great picture are unintelligible to any one who is not himself a painter. You will remember the picture by Whistler, at the Metropolitan Museum of Art in New York, called "A Woman in White." Although executed in oils, it is wholly in black and white. We are told that it was painted to show that certain effects could be produced in oils without the use of color. Here then is a painting that artists deem a great one, although to the general public it has no subject at all and conveys next to nothing. The majority of modern paintings belong to the same class and it has gotten to be well understood that artists are to paint only for other artists. In any definition of a great painting, skill and technique are indispensable, but a man is at once called a Philistine if he asks that artists use their talents for some other purpose than merely to record and exhibit personal achievement.

Painting and poetry are arts that in their essentials are much the same, their chief difference being one of tools. But while the painter has glorified his tools more and more, the poet has kept his head, and has not forgotten what tools are for. I suppose it would be possible to construct a poem without using any other vowels than *e* and *u*. If so we should have the literary counterpart of Whistler's "Woman in White." Of course such an effort would not be regarded seriously for a moment, nor should we tolerate in literature any mere exhibition of technique. Yet technique is quite as indispensible here as in painting, and great facility is as rare in the one art as in the other.

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## A METEORITE FALL IN ENGLAND

In *Nature* for November 5, 1914, is an interesting account of a meteorite which fell in Lancashire, October 13, at 8.45 p.m. Its arrival was preceded by a very vivid illumination of the heavens, together with rumblings and explosions sufficient to shake windows, much as in an earthquake shock.

The fallen body was found at Appley Bridge, four miles W.N.W. of Wigan, in a hole 18 inches deep. When dug out it

was found to weigh 33 pounds and in appearance it looked like a piece of burnt iron. Mr. Denning finds that its course was from S.S.E. to N.N.W., its probable radiant being at 348° + 2°, in the western region of Pisces. The last 49 miles of its path was traversed at a velocity of about 8 miles per second, the height declining from 29 miles to 0.

The previous recorded falls in England and the last one in Ireland are given in the following table :—

1795, December 13, Wold Cottage, 56 lbs.
1830, February 15, Launton, 2¼ lbs.
1835, August 4, Aldsworth, 1 lb. 2 oz.
1876, April 20, Rowton, 7¾ lbs.
1880, March 14, Middlesbrough, 3½ lbs.
1902, September 13, Crumlin, Ireland, 9½ lbs.

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## AUDIBILITY OF THE AURORA

For some time I have been interested in the aurora, especially in the question of its audibility. On examining the *Transactions* of our Society, particularly for the years 1892, 1893, 1894, considerable positive evidence that different members had heard sound accompanying auroral displays was found. In several volumes of the JOURNAL, also, further definite observations of the effect are reported ; and it is hardly possible to withhold assent in face of such statements.

But it is a little disconcerting when trained explorers have carefully listened for the sound, under apparently favorable conditions, but have heard nothing. Recently I came across an instance of this kind in a book by a missionary-explorer of our Canadian North-West, Egerton R. Young, entitled, "Stories from Indian Wigwams and Northern Camp-Fires." Referring to some fine auroræ, he says :—

"Often have I seen a cloud of light flit swiftly across these ever-changing bars with a resemblance as natural to that across the strings of a harp that I have suddenly stopped and listened for that rustling sound which some arctic travellers have affirmed they have heard from these auroral displays ; but although I have

often watched and listened amid the death-like stillness of this dreary land, no sound have I ever heard. Amid all their flashing, changing glories they seemed as voiceless as the stars above them."

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## THE WAR AND THE ASTRONOMERS

The various journals received now-a-days show only too well the disastrous effect of the present world-war upon scientific effort, including astronomy. Many of the workers are in the war and already numerous deaths and wounds are reported. The Director of the Paris Observatory, Mr. J. Baillaud, has six sons and sons-in-law in the field. The observatory of Mr. Jonckheere at Lille has been destroyed and its director is now at Greenwich. The Royal Observatory of Belgium, at Uccle, a suburb of Brussels, was transformed into an ambulance station in August and the astronomers acted as officers of the Red Cross. In Harvard *Bulletin*, No. 571, dated November 9, 1914, is an ephemeris for Delavan's Comet, by G. Van Biesbroeck, of the Uccle Observatory, and the following note is added:—"Computed during the anxious days of war, taken over to London by a friend leaving this unhappy country via the Hague." The *Gazette Astronomique*, formerly issued by the Astronomical Society of Antwerp, was suspended when that city was taken by the Germans, and an endeavor is being made to begin re-publication in England.

To us in Canada, accustomed to the ways of peace all our lives, and living in quiet friendship and trust with our neighbors, this war, with its ruthless slaughter and pillage, appears an enormous crime, though I suppose we cannot half appreciate what those in its midst have suffered. Those responsible for the awful catastrophe will surely have a heavy burden to bear. "It must needs be that offences come, but woe to that man by whom the offence cometh!"

C. A. C.